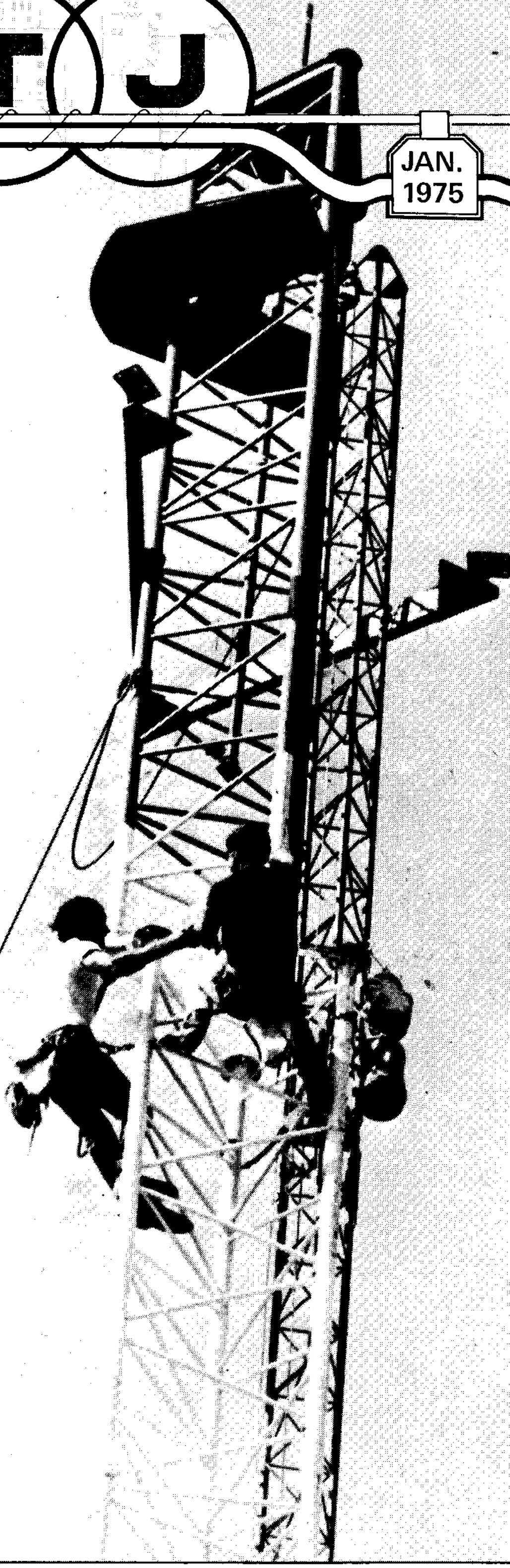
CATJ

JAN. 1975



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OUR COVER

Stacking tower is one of those things very few of us ever personally experience. Hoisting this 22 foot, 40 inch face section into place are two experienced riggers from U.S. Tower Company, nearly 900 pounds of steel several hundred feet above ground.

CATA-TORIAL

KYLE D. MOORE, President of CATA, INC.

FAIR IS FAIR

For some reason FCC Chairman Richard E. Wiley persists in the illusion that the Federal Communications Commission is a "fair agency". He repeats it so often and in so many forums, one wonders if the man really believes his own statements. We are reminded of the pre-World War II European philosophy that if a man or regime repeats a story (lie?) often enough, people begin to believe it!

During an NCTA sponsored meeting in Washington for State and Regional CATV Association Presidents, Wiley "dropped in", uninvited. NCTA's present Prexy, David Foster, escorted the Chairman to the front of the meeting where he talked off the cuff for a few minutes, and tried hard to "rebut the stories he hears that he and his commission are very pro-broadcasting and not about to do any favors for cable". Wiley said, "I have an open mind about all matters brought before the Commission."

The history of the Commission's handling of the poor, overburdened CATV industry does not bear out that statement. We are reminded that President Ford has asked for the creation of a **National Commission to Study and Report on the Impact of Independent Regulatory Agencies** on the industries they regulate. This sounds like an excellent idea, but if past history of "National Commissions" tells us anything, the CATV industry **will be past history** before such a Commission could ever reach the logical conclusion that the FCC has treated us unfairly from the minute they became involved in Carter Mountain.

We are also reminded that two U.S. Senate Committees—Commerce and Government Operations—are currently studying the same matter. We recall that when we read the testimony of FCC Chairman Wiley before the Senate, he declined to give hard answers on his regulatory agency favoritism.

The facts are that the FCC continues to function under the often-quoted Communications Act of 1934 (which in truth was a very lightly dusted-off version of the Communications Act of 1927). Section 303G of the 1934 Act charges the Commission with the responsibility of "promoting the uses of radio" (television is not mentioned in the act). Naturally not one page of the act deals with CATV. Yet, this is the act we live under, and the act from which the Commission promulgates rules.

During the late 1950's and 1960's, CATV grew so fast that a regulatory vacuum was created. Between the "poor, dumb cities" who merely had the common sense to license us to utilize their easements and our "poor, dumb subscribers" who merely had the common sense to pay us money **when we delivered what we promised** stood 40 hard miles of no regulations. Into that vacuum between 1960 and 1972 rushed the FCC. Going back to Carter Mountain (the first FCC microwave case, in which the first quasi-jurisdiction of CATV by the FCC was assumed) and reading forward until today, one finds not one, or dozens, or hundreds, but **thousands** of examples of FCC favoritism to the establishment: **broadcasting.**

Under the pretense of "saving the poor, dumb cities and the poor, dumb subscribers" from the "menace" of an unregulated CATV industry, the FCC has set up the most complicated, most complex, most underhanded rules and regulations ever conceived by the mind of man; and the broadcasters have been laughing all the way to the bank ever since.

Now perhaps the present FCC Chairman **really does believe** he is a fair man. Perhaps he believes his own press-agentry and gladhand statements. If he does, it has to be because he has never taken the time to sit down with approximately forty pounds of paper and read the history of **The FCC vs. CATV,** from Carter Mountain forward; and because he inherited a Commission with a tragic history of suppressing a new technology that offered new hope to dis-enfranchised television viewers.

So in March, CATJ is going to help the Chairman bone up on the **true history** of CATV. We are devoting virtually the entire issue to not one, or dozens, but **hundreds** of irrefutable examples of Commission mistreatment of the CATV industry. These examples will come from the Commission's own records and statements through the years. Every member of Congress, every Governor, and thousands of others will receive this special issue.

Perhaps there will be a message here for the Chairman, a message similar to the one he offered to an Iowa CATV operator in Washington December 13th when the CATV man pleaded with Wiley, "Please, when you make all of those rules and regulations, remember there are small systems like mine with eight-hundred subscribers." Wiley answered, "Sorry fella, that's the price you pay to be in business."

CABLE CAPTIONS

Two Can Play. When a power company in the Southwest told all operators it was going to double pole attachment rates, operators in the area banded together and engaged services of a well-known California attorney who has been instrumental in CATV battle with California's giant PG&E power company which wants the same "doubling of attachment rates". The Southwestern power company went so far as to order a Denver City, Texas CATV system "off the poles" by a mid-November date if it refused to sign a new pole attachment contract at double rates. The power company then backed off when the California legal type started talking about a multi-million dollar suit. Meanwhile back in California, "talk of a multi-million dollar law suit" against PG&E has **apparently** run its course. PG&E notified an Arvin, California system on November 25th that it had until December 15th "to sign and return the contract agreeing to new $5.00 per pole per year rates" or, "remove equipment from PG&E poles by December 31st".

Another PUC-able State? The Pennsylvania state association of operators, scheduled to have a Board meeting December 28th, was to take up question of "agreeing to support" a watered-down version of a bill which will establish a state regulatory agency, a la New York State, in Pennsylvania. The general feeling is that **while** Jerrold founder, Milt Shapp, is Governor of Pennsylvania, timing is good to accept PUC-fate when operators "have a friend" in the state-house. Assumption is that bill will be modeled after New York State bill, but initially will be milder in tone and requirements.

Low-cost undergrounding? California operators, headed by Frank Williams of Televents, in Concord and Martinez, have developed a novel approach for heading off spiraling costs of going underground in new sub-divisions. Capitalizing on the present reluctance of many city fathers to "take new sub-divisions into their respective city limits" (and thereby assume city liability for city services) when the costs of everything including running new water and sewage lines are increasing, Williams and other California operators have been successful in getting several California towns to modify CATV ordinances to state that the **developer carries the burden** (and expense) **of placing CATV plant underground.** In effect, the developer has to carry the cost of putting in all utilities himself, and this includes CATV costs of going underground. "California aerial costs currently run to $7,000 per mile (average)", notes Frank, "and underground is $18,000 per mile." Now, when a developer thinks about opening a mile of new tract development for homes, he has to "pay for CATV costs to pre-wire distribution lines" into his tract. Very neat, Frank.

Handwriting on the wall? Rumors of further cut-backs in NCTA staff personnel appear to have some validity. One staff member told CATJ, "I think IOB is dead with the resignation of Jim Y. Davidson, first IOB chairman, and the fuss put up by other IOB members such as Ben Willie of Iowa over the NCTA copyright stance. With the refusal of more than five IOB people to attend the Washington meeting December 12-13, it appears IOB head Beverly Murphy may be among those to go early in the New Year." Bev originally joined NCTA in 1960 and is the oldest continuous service member of the staff.

Copyright Hearings Set? Congressman George Danielson (California) told the California operators' meeting in Anaheim, "Our House Judicial Sub-Committee Number Three has tenatively agreed to hold two sets of hearings on the copyright bill. The first will be general type hearings to determine areas where more specialized and detailed hearings should take place. We already know CATV will be one of the subjects for specialized hearings, and we anticipate ten days of specialized hearings." Pressed for dates on when the first and second round of hearings might take place, the Congressman declined to speculate.

CATA Newsletter Expanding! Once each month the Community Antenna system operator members of the Community Antenna Television Association (CATA) receive something called the CATA NEWSLETTER. Copies also go out to approximately six hundred non-member systems. Among other topics regularly covered in great detail in the Newsletter are copyright, over-regulation and FCC internal activities relating to cable. If your system is not presently receiving the CATA NEWSLETTER, and you would like to receive it as a means of keeping up with the **real social events** of our time, you may do so by requesting a copy from CATA, 4209 NW 23rd, Suite 106, Oklahoma City, Oklahoma 73107.

CHANGES IN MEASUREMENTS — Before you read this the FCC is expected to announce changes (described as "editorial in nature") in **method** of measuring in channel (frequency) response (76.605 [a] [8]). Present reading calls for +/— 2 db "flatness" from -1 MHz to +4 MHz, reference video carrier; "editorial change" will read -0.75 MHz to +4 MHz. Readers are directed to Pages 30, 31, 32, 33 and 34 of December CATJ, and the subnote on the bottom of Page 31. You are advised to modify your own testing procedure accordingly for 1974/75 compliance tests.

SIGNAL PROPAGATION (PART THREE)

FADING AS FUNCTION DISTANCE

We depend upon the lower atmosphere to "transport" the desired signal(s) from the transmitting antenna to the receiving antenna. Previous articles have explored anomalous propagation and typical on-path problems as they relate to VHF (and UHF) signal transmission (1).

Most learned treatments of the mechanics of wave propagation rely *heavily* upon *mathematical analysis* of what is "supposed to happen" between two points, knowing (usually) only the parameters at the *transmitting* end and the *receiving* end. What actually takes place between the two is heavily theory.

If we could "color" the transmitted wave form with some tint which the eye could see, it would be possible to "follow" the wave front from the transmitting antenna to the receiving antenna and actually *observe* the mechanics of transmission. Unfortunately, this is not possible so we do the next best thing; measure the received wave front at *as many different points along a path* as possible and interpolate the direct observations at descrete receiving points to fill in the "missing nonobserved holes" along the way.

One of the most forgotten or underrated variables is the effect of frequency upon the actual characteristics of the observed signal. The transmission medium (the lower atmosphere) is seldom a static thing. The qualities of the medium are constantly varying or changing simply because the atmosphere itself is a turbulent creation. Only in very rare (inversion) situations does the atmosphere stabilize and then for only relatively short periods of time. The normal state of the lower atmosphere is change, constant change. We identify this constant state of flux as "fading" in VHF and UHF reception because that is the end result, as determined by our receiving equipment, of the constant change.

In a sense the lower atmosphere *modulates* the *mean* received *signal level.* Just as an AM transmitter *swings* the amplitude of the transmitter carrier (in effect) so too does the constantly changing *refractive index* (2) of the lower atmosphere *"swing"* the "amplitude" of the carrier being transmitted through the transmission medium.

With an AM (amplitude modulated) transmitter the degree of "swing" is set at the transmitter and it does not vary once set. However, the "swing" in received (RF carrier) amplitude *caused by the changing refractive in-*

(1) See **Wave Propagation,** Sept. 1974 CATJ and **Day In The Life,** Oct. 1974 CATJ.

(2) Refractive index is the meteorological measurement term determining the amount of signal bending vs. temperature and moisture.

TABLE ONE

	0 Miles / Visual Horizon	Visual / Radio Horizon	Radio / radio + 50%	Far Scatter Region
50-120 MHz	5-10 scale	10-20 scale	20-50 scale	30-60 scale
120-240 MHz	5-15 scale	10-30 scale	20-70 scale	30-80 scale
UHF TV Range	5-20 scale	10-40 scale	20-80 scale	30-90 scale

Table depicts relative "depth of fading" likely to be experienced on scale of 0-100, within various distance ranges, for low band, high band, and UHF.

dex of the atmosphere *increases with distance*. It is at a minimum close to the transmitter source and is at a maximum when we reach the scatter region.

This is where the relative effects of the transmitter frequency come into play. One of the better understood characteristics of the lower atmosphere as a "modulating medium" is its ability to enhance the "degree of swing" as the *transmitter* (and receiver) *frequency is increased.*

For example, if we assigned an arbitrary scale of 1 to 100 to the amount of swing which could be measured (or observed) in real life and then broke the observed amount down for given distances between transmitter and receiver, we *might* come up with a representation such as is shown in Table 1.

The emphasis here is on the word *might* since we are dealing with an unstable (and virtually unpredictable) modulating medium. The lower atmosphere derives its characteristics from such factors as (1) percentage of *water vapor* content present (2) location, intensity, direction of flow *localized updrafts* (3) consistency (or variations) in *barometric pressure* between transmitter and receiver (4) horizontal *wind patterns* (5) *pockets of stagnant air* surrounded by nonstagnant air (6) degree, and type of *air pollutants* present and other factors. Over a 3, 30, or 300 mile path there is *seldom consistency* of all these factors. If we were able to take the full length of the path apart *wavelength by wavelength* and minutely examine the character or flavor of the mix of these ingredients, we would quickly see that it is a wonder that any signal *ever* gets beyond the visual horizon! There is *so little mathematical chance* for everyone of these factors to *stabilize and work together*, in phase, to carry the desired signal beyond the horizon, it is no wonder that some CATV manufacturers who do turn key work just automatically throw up their hands in horror when the CATV operator "suggests" going beyond the radio horizon for a direct pick-up point. "You must go towards the station and pick up the signal, microwaving it on to your town" we are often told.

We refer to the refractive index as a convenient method of *monitoring* the ability of the lower atmosphere to carry signals *beyond* the visual horizon. Basically, the refractive index for a path can be brought down to a pair of ingredients which *most* affect the efficiency of the lower atmosphere as a transmission medium: the *moisture content* and the *air temperature*. Both factors are monitored daily by the United States Weather Bureau at hundreds of weather monitoring stations across the country. As the charts show, the water vapor content of the atmosphere decreases with altitude. So too does the temperature. The degree of change with altitude is a linear function and as long as it stays within the linear rate of decline parameters, we are led to expect from years of observation, conditions remain normal. It

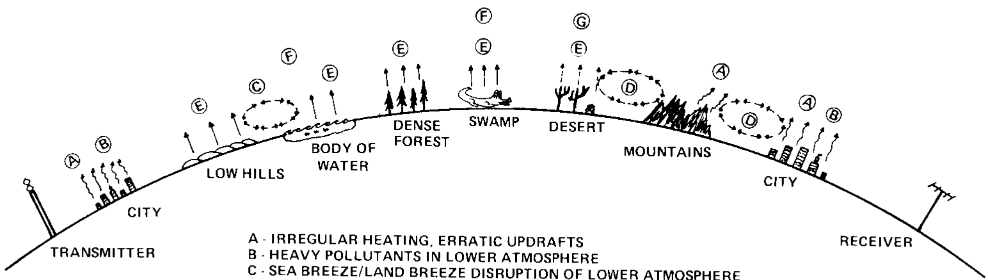


DIAGRAM 1

is when they change (i.e. temperature *increases* with altitude for the first few thousand feet; temperature decreases as expected for 1,000 feet, then *abruptly reverses* and increases with altitude for the next 1,000 feet, etc.) that an anomalous condition is created (1). As previously discussed in this series, this is termed a *positive anomaly.*

When a positive anomaly occurs over a large region it is called an *inversion.* We experience increased signal levels with inversion conditions, often from nondesired stations as well as desired stations (thereby creating co-channel interference). When the condition exists over a very small area and usually for a very short period of time (seconds or less) we experience momentary up-fades that create temporary problems for our system AGC in our head end processing equipment.

Under normal (i.e. noninversion) conditions this type of thing *happens almost constantly* (or consistently). But it happens *only* for *short periods* of time and for a very *small percentage* of the total path length. Unlike a general state-wide or region-wide inversion, the *portion* of the transmission path affected may be as small as a *few wavelengths* in length. You could create an imaginary path and measure many, many descrete "anomalies" *simultaneously* on that path. But the measurement of the multitude of anomalies would *only be valid* for the *instant* during which the simultaneous full path measurements were made; *just seconds later* the path would check out entirely different.

FACTORS INFLUENCING LOCALIZED ANOMALIES

Let's keep in mind as we go on with our study of wave propagation that *no two paths are alike.* Even the fellow a few miles away from you with his CATV head end is experiencing different conditions than you *if both are measured at the same instant* or point in time. On the average, if you are not very far apart your levels should *average out about the same* as his do, provided the two paths are quite similar. But the *only time* you both start seeing the same type of signals at the same time (i.e. instant) is when an *inversion* covering the entire region exists. Only then does the *atmosphere stabilize* to the point that all of the individual little localized anomalies are overriden by the domination of the inversion propagated signal(s).

In Diagram 1 we have taken a path and thrown in a few ground level factors which tend to have known influences on the lower atmosphere directly above them. These influences cre-

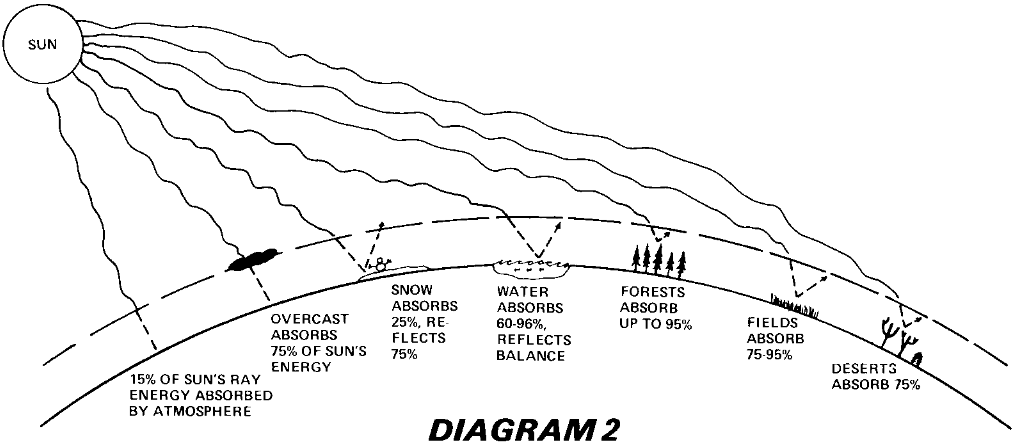


DIAGRAM 2

ate, disburse, and recreate localized anomalies throughout the day. If the signals must pass over these areas, between the transmitter and your receiver, these localized anomalies are constantly changing in character and creating positive and negative fading on your received signal, above and below the "average signal level" you tend to expect.

Virtually all paths have *localized anomalies* along the way, even over water paths. Paths that have vastly differing characteristics, along the path, are the most difficult ones to bridge since there are many more anomaly "creators" at work.

THE TWO BIG FACTORS

In addition to the localized anomaly conditions that exist over very short periods of time on virtually all paths (and which constantly change) we have two major factors that affect all of these conditions daily.

The rays of the sun is the most pronounced factor. The rays of the sun *heat the atmosphere* and the earth below when the earth is not shielded by cloud formations. This heat sets currents into motion. When the earth is heated by the rays *the hotter air rises.*

Approximately 43% of the solar radiation reaching our planet is absorbed by the earth's surface. Another 42% is reflected back into space and the remainder is absorbed by the atmosphere. The 43% absorbed by the earth and turned into heat is *an average* for the entire earth. Individual earth features have different degrees of *absorption efficiency.*

For example, snow covered ground absorbs only 25% of the sunlight that reaches it. Bodies of water absorb from 60 to 96% of the sunlight reaching the water (the exact percentage depends upon the angle of the sun's rays, with the greatest absorption in the summer when the rays are directly overhead). A field of grass absorbs from 80-90% of the sun's rays, deserts absorb but 75% of the sun's rays, dense forests absorb up to 95% and plowed fields between 75% and 95%. The amount of absorption is more than academic because the *percentage of absorption determines* the degree or extent of *localized earth-heating* by the sun. Which in turn determines the amount of sun heated air which rises over the heated region into the lower atmosphere, *causing local air turbulence* and *localized anomalies.*

Regions of the earth which are heavily broken up by terrain irregularities or man-made irregularities (i.e. cities) have very uneven heating and therefore very *uneven columns of heated air* rising over them.

A path that crosses over water for the entire distance from transmitter to receiver has localized but regular (i.e. similar) heating patterns for the entire path. Fading rates tend to be more regular over such paths, although still erratic.

A path that crosses over a city, a forest, a series of grassy fields and plowed fields, and then a desert will have more *extreme fading* simply because *each* of these individual localized heating patterns along the path *creates its own* highly erratic *anomaly formations.*

In the summer the sun is most directly overhead. This creates a "high angle of entry" through the atmosphere for the sun's rays and more of the sun's rays create heat. The opposite is true in the winter. *Heated air rises more in the summer* than in the winter simply because there is more heating.

Even an overcast day has some of the sun's rays reaching earth. Because cloud density varies within an overcast, some of the sun's rays penetrate further into the clouds than others, i.e. not all of the reflection from clouds occurs at the *top* of the overcast. The portion that penetrates well into the overcast has an effect on the level (i.e. altitude layer) of the atmosphere it reaches, creating uneven eddies of heated air. Approximately 25% of the sun's rays *do penetrate* a full overcast, so even then we have *some heating* of the earth and the attendant rising of heated air.

The second major influence on the strength and life of localized anomalies is the weather pattern present over the region. Here we are primarily concerned with the *amount of moisture present.* Water content enters the equation simply because irregularities in the percentage of moisture present along a path cause highly *localized extremes* in the *refractive index* of the air along the path. If a "glob" of (localized) air along the path has a *higher moisture content* than the other areas around it, the *refractive index* of that glob is higher than the surrounding air. And the "glob" will propagate signals passing through it better than drier air directly around it.

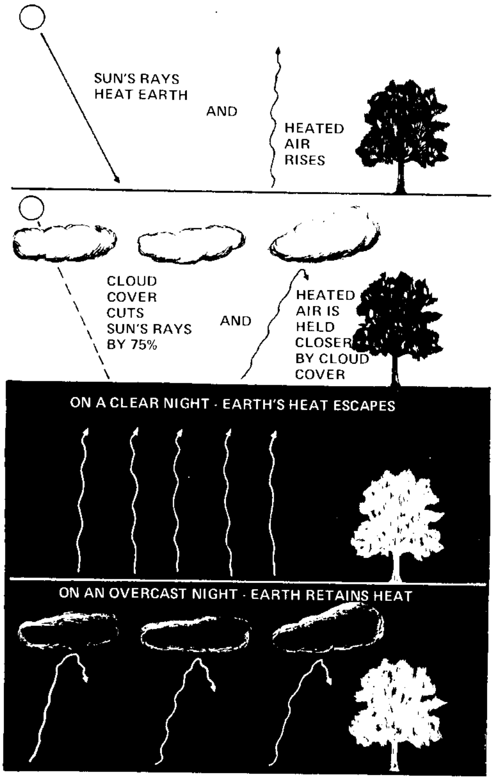


DIAGRAM 3

Now very low moisture content air is not *in itself* bad. A path that passes over a desert for the full path will have a *lower* fading rate than a path that passes over dense forests for the full path.

A *consistent* heavy moisture content is not necessarily a good omen; paths that pass through *heavy rain* for the full length are not propagated especially well, primarily because when the moisture gets that high the signal absorption within the rain begins to become appreciable.

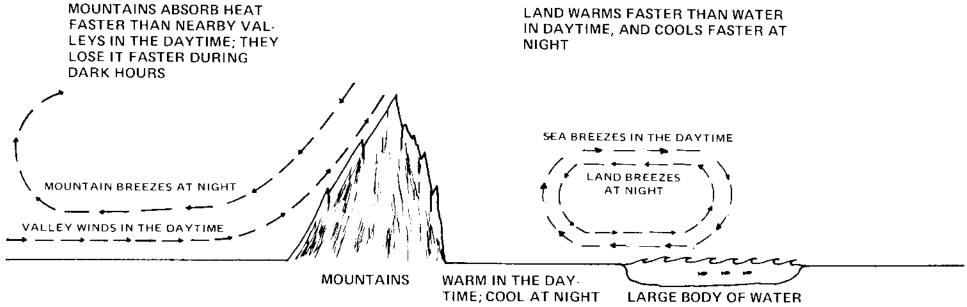


DIAGRAM 4

Weather patterns influence path efficiency primarily because of the way they modify the norm, *enhancing* the normal signal levels when conditions approach an *inversion* situation, *degrading* the normal signal levels when conditions are extremely *unstable* (i.e. along a line of thunder storms). In between the two extremes we have the days and days and days when fronts cross and crisscross our region, lows move through and highs settle and stagnate.

In areas where daily localized winds associated with the terrain are present, they too tend to modify the anomaly situation. For example, along a large body of water there are sea breezes in the daytime and land breezes at night (see Diagram 4). These local winds are caused by the differences in earth heating. Land

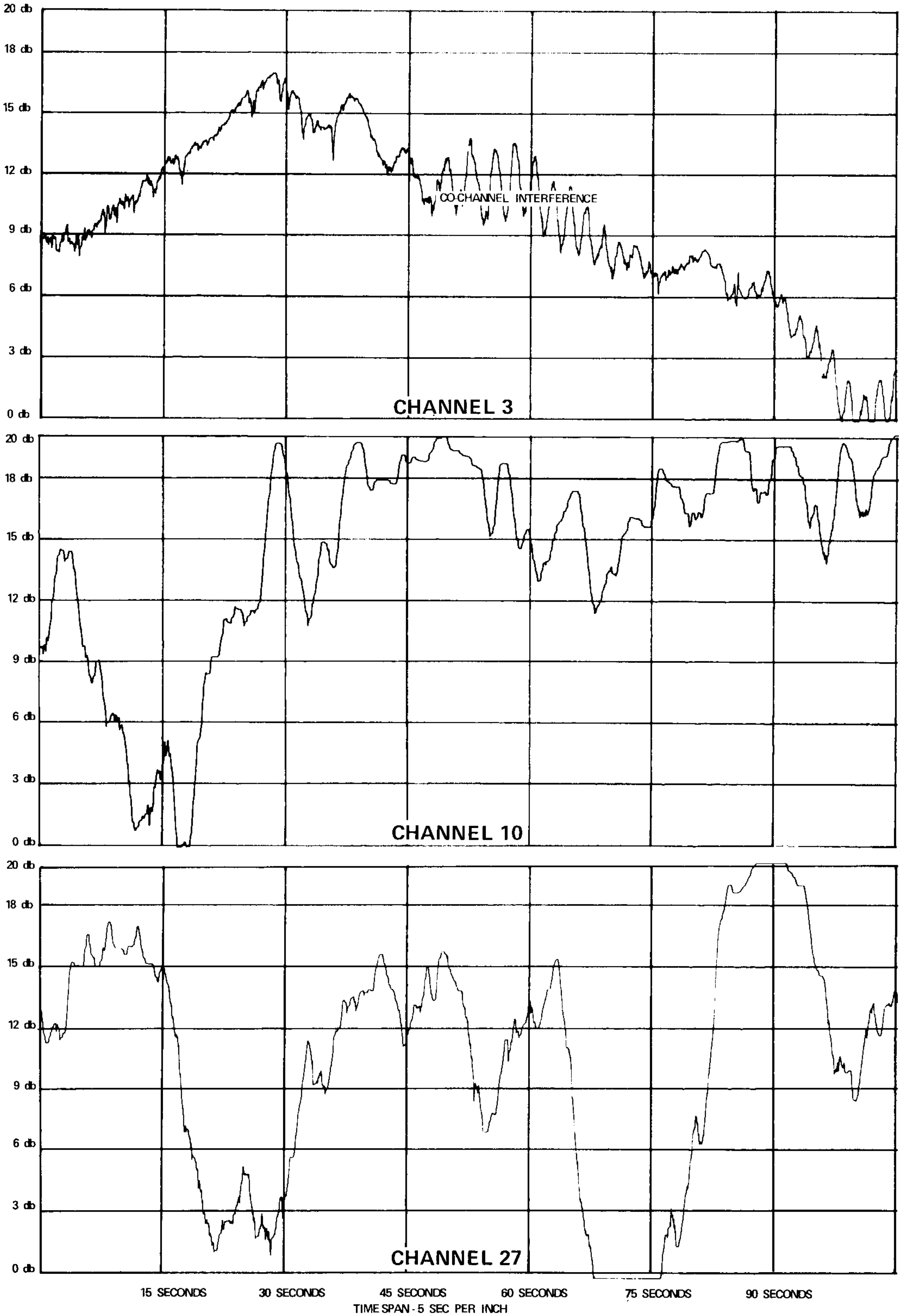
AT 5 SECONDS PER INCH

The charts appearing on the opposite page were run at 5 seconds per inch to illustrate the depth of the fading ranges within very short time spans.

Channel 3 (chart at top of page) begins with the signal purposefully pad adjusted to be 9 db out of the noise (bottom of chart) at the 0 second mark. It peaks at the 25 second mark 17 db out of the noise, having gotten to that point through a slow rolling fade that had less than 1 db "pumping action fades" of under a second each impressed upon the rolling up fade. Between 45 seconds and 70 seconds, the signal has indicated +/— 2 db "pumping action fades" superimposed on the gradual descent of the signal. A similar set of "pumping action fades" shows up as the signal heads for the noise in the last 15 seconds of the recording. Both sets of "pumping" was due to the sudden appearance of **co-channel** during the recording session, at about the same level as the desired signal, and the in and out of phase relationship of the two signals, as detected by the peak reading detector in the FSM that provided voltage to drive the chart recorder head.

Channel 10 (the middle chart) begins with the recorded signal pad-adjusted 14 db out of the noise, but fading down to the reference noise level at the 15 second point. For the balance of the recording period the signal averages between 12 and 20 db out of the noise running in 10-20 second cycles between peaks (or 5-10 seconds between peaks and nulls). Channel 27 (the bottom chart) begins at a level 14 db out of the recording system noise, peaks at 17 db out of the noise around 8 seconds into the run, but drops to 1 db out of the noise 20 seconds into the run. Notice in particular the abruptness of the signal level changes for the UHF signal and the small "hooks" in the up fade at 76 and 79 seconds as the signal heads for the top of the chart. For nearly 10 seconds the signal was at the system noise level (66 to 75 seconds) but its recovery to nearly the top of the chart (82 to 91 seconds) was very steep and pronounced.

Continued on Page 14


20 db
18 db
15 db
12 db
9 db
6 db
3 db
0 db
CO-CHANNEL INTERFERENCE
CHANNEL 3
CHANNEL 10
CHANNEL 27
15 SECONDS
30 SECONDS
45 SECONDS
60 SECONDS
75 SECONDS
90 SECONDS
TIME SPAN - 5 SEC PER INCH

warms *faster* than water during the daytime and cools *faster* at night. When these winds blow *through* or across a receiving path they affect the formation of localized anomalies. For any anomaly to last long enough for signals to stabilize, the atmosphere must be stable. The constant erosion of the atmosphere by sea or land breezes doesn't give the anomaly much of an opportunity to form.

FADING SIGNATURES

Signals do fade, even within the high signal level regions. The extent of the fading is unimportant as long as it stays within the AGC range which we are able to handle with our head end processing AGC system. However, knowing the extremes we are likely to encounter in fading is important so we can be certain we have proper AGC protection.

A detailed feature on fading types and how antennas can be designed to compensate for the fading experienced will appear in a future issue of CATJ. For now, let's look only at the fading signatures associated with the localized anomalies which we have been studying.

Recall that *anomaly formation and dispersion* actually "modulates" the received signal level, in the sense that variations in the received signal level are caused by one form of anomaly or another. The *rate* of modulation (the *time span between* maximum and minimum peaks) is a function of frequency and distance (path length). The *depth* of modulation (the *db difference* between maximum and minimum peaks)

Continued from Page 12

In comparing the three fading rates, it would be well to notice that while the low band signal fades slowly, in a fairly long term "rolling fade" the high band signal is fading considerably faster. The UHF appears to be fading more often than the high band VHF.

During the 100 seconds of recording time shown here, the low band signal went through less than one complete peak-to-peak fade cycle. The high band signal went through just under five complete fade cycles, although the clear delineation of some of the "pumping action fades" that break up the distinct fade cycles tends to hide the true peak-to-peak fade cycle. The UHF, on the other hand, has six somewhat clearly defined peak-to-peak cycles in the 100 second period.

The higher fade rate and the differences in fade depths is clearly evident as you compare low band, high band and UHF on these charts.

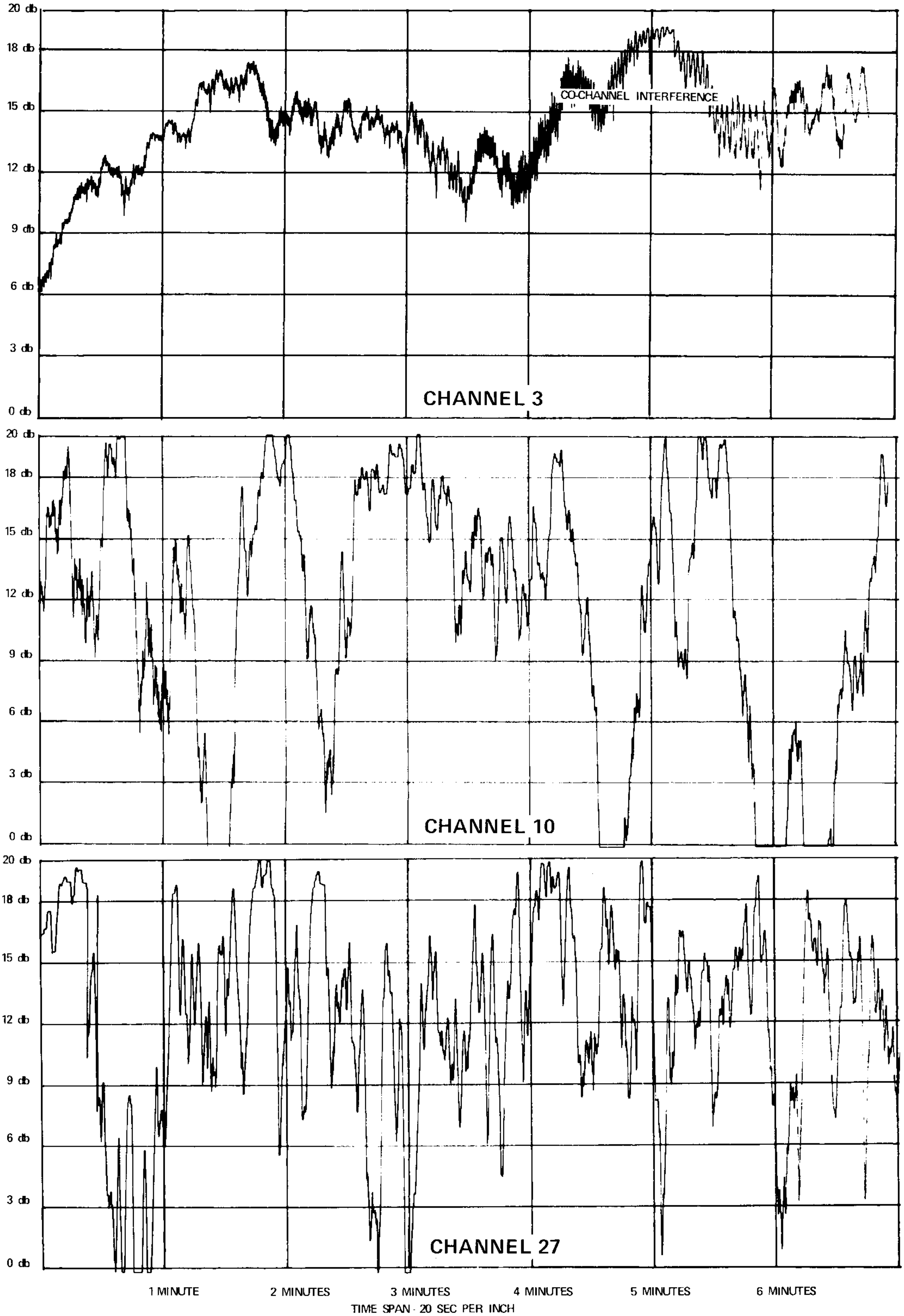
AT 20 SECONDS PER INCH

The charts appearing on the opposite page were run at 20 seconds per inch to illustrate the fading **cycles** which could not be shown with the 5 seconds per inch format.

Channel 3 (chart at top of page) has a very similar appearance to the 5 second per inch format. The slow rolling fade holds up for extended periods of time as well. Around the fourth minute of the chart, the same on-channel (cochannel) source that "pumped" the recording pen on the 5 second per inch format appears again, "modulating" the fading sine wave a few db either side of the actual fade condition itself.

Channel 10 (the middle chart) is very difficult to quantify for the number of complete fade cycles in the 400 second measurement period. The appearance and disappearance of localized anomalies sufficient to cause erratic fades and peaks at high band is exceedingly evident in the chart recording.

Channel 27 (the bottom chart) illustrates again that if the high band is difficult to quantify for fade frequency, UHF is impossible. The suddenness of the fades, the exceedingly short time span between peaks and nulls becomes even more pronounced at UHF than at high band.


20 db
18 db
15 db
12 db
9 db
6 db
3 db
0 db
CO-CHANNEL INTERFERENCE
CHANNEL 3
CHANNEL 10
CHANNEL 27
1 MINUTE
2 MINUTES
3 MINUTES
4 MINUTES
5 MINUTES
6 MINUTES
TIME SPAN - 20 SEC PER INCH

is almost solely a function of transmission path frequency.

We have recorded off-the-air signals to illustrate this latter point. Three signals, operating from the same market and received beyond their radio horizon (within the scatter region) were recorded at relatively fast chart recorder speeds of 5 seconds per inch, and 20 seconds per inch. This fast speed gives us excellent definition (at 5 inches per second of chart we are able to see most of the *minute* signal changes that occur in time). Since we are *primarily* concerned in *this report* with the formation and dispersion of anomalies (localized anomalies along the path) we need this kind of definition.

The three signals operate on channels 3 (61.25 MHz visual) 10 (193.25 MHz visual) and 27 (549.25 MHz). The absolute (microvolt) signal levels recorded are *important* for this report; note only that the receiving system was pad-adjusted so that the bottom chart line represents 0 db *signal-to-noise ratio* and the vertical height of the chart is 20 db per chart. When a signal "pinned" the recorder marking pen against the top of the chart we had a 20 db *indicated* signal to noise ratio.

The charts were reduced 50% of actual size, and legends placed to note what it is you are looking at. They were then reduced another 50% and thus appear here at 25% of their original size. This has been done to allow placement of the charts three to the page. Channel 3 is at the top, channel 10 in the middle and channel 27 on the bottom.

The displays are first the 5 seconds per inch run then the 20 seconds per inch run. By showing the three same-speed charts together on the same page you can compare directly the effects of frequency on the *rate of anomaly modulation* and the *depth of anomaly modulation.* Keep in mind the elapsed time from start of chart to finish of chart is identical for all three frequency measurements.

WHAT IS NORMAL?

Selecting a "normal day" to prepare these recordings leaves a great deal of latitude in the hands of the recording engineer. The charts were made during the past summer, when the following general weather conditions existed along the path, or within 100 miles either side of the path:

A stable, high pressure area lay over the path. A southerly wind was pumping moisture into the high pressure area out of the Gulf of Mexico and indicated average signal levels were from 3-6 db above normal for summer time levels. There was no evidence of thunderstorms or other "heavy weather" in the area. The time of day was during the early afternoon hours to minimize any possible inversion-enhancement effects that might exist.

Similar recordings will be made of this path during the winter and both will be run side by side at a later date to illustrate the changes which take place between summer and winter time signal levels.

This series on wave propagation will continue in an early issue of CATJ, featuring antenna system designs to minimize the effects of fading from localized anomaly conditions.

FOURTH NETWORK UNDER YOUR NOSE?

76.61 (e) (2) SAYS

When the Cable Television Report and Order (i.e. Part 76) was adopted in March of 1972, no mention was made of that situation where local network affiliates chose not to carry certain of the the network releases. However, the fact is that very few (if indeed *any*) network affiliates carry *each and every program* released by the network. Network types refer to this as the "program clearance problem" and the ultimate national popularity of any given show is often determined by the number of stations which "clear that program for local showing".

Thus in the Reconsideration of Cable Television Report and Order, adopted and released June 26th, 1972, Section 76.61 (e), which initially dealt only with carriage of foreign language stations, was expanded to state:

"Cable systems may (also) carry:

(1) Any television stations broadcasting predominantly in a non-English language;

(2) *Any television station broadcasting a network program that will not be carried by a station normally carried on the system. Carriage of such additional stations shall be only for the duration of the network programs not otherwise available, and shall not require prior Commission notification or approval in the certificating process."*

This is a very significant section of Part 76, because it provides the alert cable system operator with an opportunity to program some network programs onto his cable system which probably will have considerable cable appeal.

Example One

Networks have their worst clearance problems with (1) weekend offerings that run in the daytime, (2) end-of-day weeknight offerings, (3) prime-time movies (on a selective

FOURTH NETWORK UNDER YOUR NOSE?

Virtually every system operating under the handicap of non-duplication protection, **or from within a thirty-five mile zone** where distant signal carriage is taboo, has the "makings" of a **fourth network readily available** to them. This report tells how FCC rules allow you to pick-up and carry, **without notice to the FCC or FCC certification,** programs originated by "networks", but not carried by local broadcasters. Typically, 20-30 hours per week of new network programming is available for the taking! Without FCC red tape, you can expand your system's program carriage as fast as you can install the equipment. Section 76.61 (e) (2) has been right there under your nose for nearly 2½ years. **Now learn how to apply it to your advantage.**

basis), and (4) some of the mid-day offerings. Of the three networks, ABC at one time had the worst problem gaining wide national clearances from affiliates for their programs, but things have pretty well evened out now so that no one network really has more problems than the other two (PBS should be included here also, although PBS stations are less apt to demand non-duplication coverage).

What you are really setting out to do is the following: (1) *Identify* from whatever sources you have handy *those network shows which do not show up on your regularly carried stations;* (2) *identify* whether those "network-originated" shows are *available to you,* at your head end, from other stations which you normally do not or cannot carry; (3) *calculate how many hours per week* of new, different, non-duplicated programming you could add to your system by picking up just those shows which are not now seen "on your cable"; (4) and finally, decide how you are going to "plug these specific shows into your cable system" for showing.

Keep in mind that the program scheduling business is *by no means a static thing.* If your local CBS (cable carried) signal opts to sign onto the Hughes Sports Network for a special basketball game on Saturday evening, then MARY TYLER MOORE, BOB NEWHART, and all of the rest of the CBS Saturday evening lineup is *dropped.* But if you have adequate advance notice, you can go to *another CBS station* (from the head end) and pick up the necessary network programs for "special showing" on the cable. This makes the cable subscribers one-up on the home viewers who don't have that "distant network signal" option, and this makes the cable company look pretty darned good in the subscriber's eyes.

Before we get too far into the specifics, let's again quote part of 76.61 (e) (2): "*. . . and shall not require prior Commission notification or approval in the certificating process*". That means just what it says. If you decide to carry the CBS lineup from station XXXX Saturday evening, because station YYYY is going to run something from some other source, you can make the decision as late as a few minutes before station YYYY leaves the network for the special program, and simply "put XXXX on the cable" *without* "prior Commission notification or approval". *Nothing could be clearer!*

76.61 (e) (2) MEANS

A few alert system operators have already found this data buried on Page 236 of the Reconsideration booklet, and have been applying it to their situation. Recall that it states, "(2) Any television station broadcasting a network program that will *not be carried* by a station normally carried on the system . . .". At least one operator did his own interpretation of this and decided that "not be carried" meant not being carried *at the network release time.* That is, if the network releases SANFORD AND SON at 7 P.M. CDST on Friday evening, but the local NBC affiliate decides to tape the release and show it at 9:30 P.M. on Sunday, the system *determined by interpretation* of the Rules that this left the system free and clear to carry SANFORD AND SON from another NBC affiliate at 7 P.M. Friday evening.

Not so, says the Commission. In a decision released October 11th, the Commission stated," Section 76.61 (e) (2) is intended to apply when a television station normally carried by the cable system *does not clear* a network program for local broadcast, or when the program (in question) is otherwise not available via normally carried signals." In the system in question, station WREX-TV of Rockford, Illinois taping four regular ABC network programs and broadcasting them at approximately the same time as the network release (i.e. same time of day), *but* three days after their network release. *Metro Cable of Love Park, Illinois* decided that the three day delay was sufficient to allow them to go for another ABC station that was simultaneously releasing the network feed as it came to them (without the three day delay). The Commission ruled that "the delay was not substantial enough to invoke 76.61 (e) (2)".

So *how long* can a local affiliate tape and sit on a program before releasing it locally, so that the cable system can invoke 76.61 (e) (2) and go for another station that is carrying the program at network release time? *The question remains unanswered.* However, CATJ has learned that a rule making is being drafted by the Cable Bureau at this time that will pin point that "tape and sit-on period" as a maximum of three to seven days, after which time the cable company is free to "invoke 76.61 (e) (2)". So much for taped and delayed programs, which probably account for only a small percentage of the shows we are discussing here. The majority of the shows we are dealing with *are never released by the local affiliates* at all.

Example Two

Keep in mind that in the "eyes of Part 76", network programming is the sacred cow. That is, the intent of the rule structure is to make available to the widest possible public *all* that networks have to offer. From a protection point of view (i.e. the station's viewpoint), when they are releasing these programs, they have the *sole right* to do so within their "exclusive zones". But when they choose not to carry the network releases, *then* the Commission says the cable company *has the right* to bring in these network shows from wherever. This applies to all systems, including those right in the city-of-license of the network TV affiliates, not merely those outside of a thirty-five mile, or Grade B, or whatever "zone".

In researching this report, we quickly came to the conclusion that what the cable industry needs is somebody with a computer and all of the TV station program schedules, with the network release schedules. Such a computer programmed to "spit out the identification of non-locally shown network shows" that meet the three to seven day delay criteria would then give each and every CATV system in the country a program guide with which to work. Doing it by hand, with several editions of TV GUIDE at hand, is time consuming at best.

After studying ten different markets for the TV week of October 26-November 1, we ended up *selecting for our example* one close to CATJ—the Tulsa, Oklahoma market. In Tulsa a modern, twenty-channel CATV system has recently gone into operation against four in-town stations (one each network including PBS). Here is what we found, for the example week:

Saturday

(1) 0900 ABC-8 does not carry DEVLIN (30 mins), available from OKC-5;
(2) 1130 ABC-8 does not carry BANDSTAND (60 mins), available from Joplin-12;
(3) 2200 ABC-8 does not carry ABC NEWS (15 mins), available from Joplin-12.

That gives us 105 minutes of new (ABC) network programming for the Tulsa, Oklahoma system on Saturday.

Sunday

(1) 0730 ABC-8 does not carry MAKE A WISH (30 mins), available on a tape delayed basis from OKC-5;

(2) 0900 ABC-8 does not carry H.R. PUFNSTUF (30 mins), available on a tape delayed basis from Joplin-12;
(3) 1030 CBS-6 does not carry FACE THE NATION (30 mins), available from OKC-9;
(4) 1100 CBS-6 does not carry TOM LANDRY FOOTBALL (30 mins), available from Joplin-16;
(5) 1130 CBS-6 does not carry NFL PRE-GAME SHOW (30 mins), available from Joplin-16;
(6) 1900 ABC-8 does not carry SONNY COMEDY REVUE (60 mins), available from OKC-5;
(7) 2200 CBS-6 does not carry CBS DAN RATHER NEWS (15 mins), available from Joplin-16.

That gives us a total of 225 minutes of new (ABC and CBS) network programming for the Tulsa system on Sunday.

WHAT IT COSTS

On this particular *weekend*, there was a total of 330 minutes of non-duplicated release material available to the Tulsa system (5½ hours total). It ran the gamut from cartoons (DEVLIN) to teen show (BANDSTAND) to sports (NFL PRE-GAME) to education/information (FACE THE NATION). Sure, it will cost some bucks for the Tulsa system to enlarge their head end receiving system to add these "occasionally used channels" to their equipment line-up. But in a marketplace like Tulsa, where the new twenty-channel system is competing with four excellent quality local signals, the cost of producing 5½ hours of programs for weekend showing *which have the viewer-sock* of BANDSTAND, NFL PRE-GAME, SONNY COMEDY REVIEW, or DAN RATHER NEWS would be astronomical.

Example Three

Now how about weekdays, which tend to be programmed identically from day to day at least into the start of evening prime-time?

Weekdays

(1) 0600 CBS-6 does not carry SUNRISE SEMESTER (30 mins), available from OKC-9;
(2) 0900 CBS-6 does not carry JOKERS WILD (30 mins), available from OKC-9;
(3) 1055 CBS-6 does not carry CBS (EDWARDS) NEWS (5 mins), available from Joplin-16;
(4) 1100 NBC-2 does not carry JACKPOT (30 mins), available from OKC-4;
(5) 1130 NBC-2 does not carry CELEBRITY SWEEPSTAKES (25 mins), available from OKC-4;
(6) 1155 NBC-2 does not carry NBC (NEWMAN) NEWS (5 mins), available from OKC-4;
(7) 1500 CBS-6 does not carry TATTLETALES (30 mins), available from Joplin-16.

So in a typical weekday, we have 155 minutes of new non-duplicated network programming, which in a five-day week mounts up to 775 minutes (nearly 8 hours) of material; and that is *not* just a little bit!

How To Use It

When you "cherry-pick in reverse" the TV stations, you of course leave your regularly carried (local, must carry) signal(s) on the cable, which means you have to find a place on the dial for the non-locally carried network shows. In discussing this with several operators who are currently adding the head end equipment to their systems to do the job (typical reaction when asked how they were handling 76.61 (e) (2) was *"You have got to be kidding! You mean I can do that!"*), we suggested that they designate at least one (and perhaps two) system channels to the purpose. We suggested calling the channel "Network Potpourri", and programming it with a slide and background music when not in scheduled use. If you have an MSI Data Channel, or some other way to keep a "coming attractions" program schedule posted, viewers would be told in advance when the next "Network Potpourri Feature" would be shown on that channel. Because this is a very changeable thing (except probably during the weekday daytime period), if the service is to be really worthwhile, *the viewing audience needs to have some way to determine what is being "shown" and when,* at least a day in advance.

Unanswered Questions

The key to the use of 76.61 (e) (2) is "carriage (by cable) of a network program not carried by a station normally carried on the system". How would we treat the Hughes Sports Network, for example? It often is one-hundred plus stations large nationally, but it may *not* have a local affiliate in your area for *the particular program* in question. Can you go outside for that "network program"? We would think that you could, although the Commission has yet to consider that question.

Watch Out for Pitfalls

If the local ABC affiliate does not clear WIDE WORLD OF ENTERTAINMENT, substituting a local movie in its place, but a local UHF independent station (which you are also carrying full time) does carry WIDE WORLD . . ., you can*not* go outside for yet a second source for WIDE WORLD . . ., even if the UHF carries it on a delayed basis (unless the delay is greater than seven days).

Prime-Time Clearances

Most network affiliates are under some network pressure to release all prime-time network shows at the time they are released. Prime-time is the biggest bread and butter period. If a station is able to pre-empt SANFORD AND SON on Friday night, chances are excellent it will show it very soon (such as in the Sunday 9:30 PM CDST/ 10:30 PM EDST non-network period) anyhow. On the other hand, many (if not most) of the network affiliates fail to clear *at least one* of the weeknight "movies". NBC-2 in Tulsa, for example, fails to clear the NBC TUESDAY NIGHT AT THE MOVIES in favor of a local movie around which they can sell *all local* advertising, at the full rate (not the deflated network rate). This leaves the Tulsa system free to bring in the NBC TUESDAY MOVIE from a distant NBC affiliate.

Summary

If you decide to expand your own system capabilities to include a "Network Potpourri" channel, spend some time studying the local clearances first. It will probably prove to be a very popular service on your cable system, almost like having a fourth network in the sense that you are providing network quality programming on a new channel. It may require some heavy planning at the head end, since you probably built a head end that was designed to bring in *only local channels*, and suddenly need the antenna/ pre-amplifier/tower capabilities of 70-100 mile signals.

Finally, you must stay at it week-in and week-out because the clearances, specials, and network schedules are not a stable commodity; they are always changing.

CALIBRATE YOUR WHIZ-BANG

Why Calibrate?

The CATV industry turns on the accuracy of its head end and plant levels, and most operators try to get as much out of each amplifier and foot of cable as the spec will allow.

If the plant layout calls for 25 db line extender spacing at channel 13, the constructor may be tempted to try to make it fly at 26 db spacing, even though the amplifier has only 25 db of gain ("So what is 1 db?" we often hear). If the head end output rating of the processor manufacturer is +52 dbmv, and the highest channel trunk input level (channel 13) *after channel combining* at the head end is +36 dbmv, all too often the spacing from the head end to the first trunk amp will be such that if the head end runs out at just 0.5 db lower than +36 dbmv, the input to the first trunk will fall *short* by that amount.

In short, *because every foot of plant is so expensive*, and because every db of active (amplifier) gain costs money, we tend as an industry to think in terms of *"maximums"* most of the time. The net result is that we are *dangerously close* to "crud" (i.e. noise, cross mod, inner-mod, etc.) much of the time. A few db here or a few db there, and *bang*, we are bitten in the behind by one form of degradation or another.

It therefore becomes increasingly important that *when* a manufacturer says we must not run his amplifier out at more than +36 dbmv that we not run it out at +37 or +38. The manufacturer *knows* where cross mod *will* occur. And we have to believe him, or run the risk of crud-laden pictures on our systems.

Yet, many signal level meters in use are at best +/— 1.5 db accurate under the most ideal of conditions, and perhaps, in actual use, they are much worse than that a fair percentage of the time. Obviously, if we are running close to the ragged edge by *pushing output specs to the limit* and we set up the amplifiers with an SLM/FSM that is reading 2 db low, we have just *exceeded* the manufacturer's spec by 2 db in actual practice. We may even blame the manufacturer of the amplifier ("...that darned thing won't make the output spec they claim for it!") when, if there is anyone to blame, it is *ourselves* for allowing our SLM/FSM to degenerate to the point where it no longer meets spec. Or, we must blame ourselves for attempting to set up a plant within a gnat's eye (i.e. 0.5 db) of its full rated output spec *with a meter that is not capable* of reading any closer than +/— 1.5 db best case!

Simply put, *calibration of SLM/FSM devices should be something you do on a routine basis*. And, if you own only *one* SLM/FSM, calibration should be a way of life.

There are *three* different approaches which you can take to calibration:

(1) *Full blown alignment:* By following the step by step data provided by the instrument manufacturer, you go through the usually considerable chore of setting the instrument up fully from front end to back end.

Typically, this requires (A) a calibrated RF signal generator, (B) a calibrated power meter, with compensation for environmental temperature, (C) a good quality VTVM, (D) perhaps a good sweep with quality detector, and (E) a handful of calibrated pads and a splitter or two.

The purpose of a real full blown alignment is to verify the *total integrity* of the SLM/FSM. In other words, to bring it up to the *original* specifications of the manufacturer. When you get all done, you will be able to read absolute levels *to the same accuracy* as the meter could when it originally left the factory.

(2) *Touch Up Alignment:* Most meters have a "short form" alignment procedure, which verifies the accuracy of the precision front end pads, and allows you to check the detector reference voltage levels. These "quickie alignments" usually avoid any work on the i.f. region of the instrument. In the process, you usually verify the correctness of the compensation setting (if the instrument utilizes one).

And if the compensation setting is "off" base, you can recalibrate the compensation setting table in the procedure. The purpose of a "touch up" alignment is primarily to check drift of compensating networks in the instrument, although you cannot be sure the SLM/FSM is operating *totally* as the manufacturer intended with a quick alignment.

(3) *Calibration Comparison:* Finally, there is the "absolute calibration comparison" system. The procedure is simple, quick, and quite painless. It should be practiced by any user of any SLM each and every day, *when the SLM is going to be utilized to check and/or set head end or plant amplifier levels.*

Simply put, before you start out in the morning, you:

(1) Check the meter mechanical zero;
(2) Check the meter electrical zero;
(3) Check the meter battery condition;
(4) And finally, run a quick check *against a known standard reference signal voltage* to determine what correction factor should be applied to any readings that day.

Unfortunately, whether you do your work after performing a full blown alignment, a touch up alignment, or a calibration comparison, the accuracy of what you read in voltage levels (i.e. signal voltage levels) on the plant or in the head end after making one of these procedures is probably *only as good* as the temperature stability of the unit you are using. (Temperature stability is the temperature *differential* between the environment you aligned or checked the unit under, and the environment which you operate the meter under.)

For even with the best and most accurate bench alignment procedure, if the meter has difficulty staying accurate as the temperature around it rises or falls, this "drift" is going to be re-

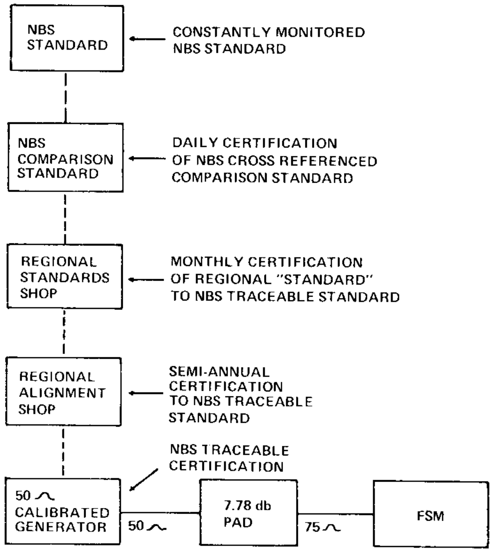


DIAGRAM 1

flected in your real life readings. We will have more to say about this later.

The Calibration Standard

We ask an SLM/FSM to do two things for us: *read absolute levels* (i.e. tell us exactly how many microvolts/millivolts of signal we have present), and tell us the *comparative differences* between signal "A" and signal "B". If a meter reads absolute levels "perfectly", chances are good it will do an acceptable job in comparative differences. For critical plant amplifier level settings and head end output level settings, "absolute" accuracy takes precedence over comparison differentials. We will seldom be called out at 10 PM at night because channel 9 is 2 db stronger than channel 10; but, if channels 2 thru 13 are 2 db higher than they should be at an amplifier input, and the amplifier is cranked wide open, the cross mod that results as the evening air cools down 40 degrees can put a crimp in our life style at 10 PM!

A *calibration standard* is simply what it sounds like—*a reference signal voltage level* which is utilized to establish calibration accuracy for an SLM/FSM instrument. A calibration "standard" that you might have in your shop is really not a standard at all. It is simply a *reference* voltage generator, hopefully exhibiting *more accuracy* than the units to which you will compare it.

There is *only one* true calibration standard; it is housed at the National Bureau of Standards in Boulder, Colorado. Every other *so-called standard* is merely a calibrated source that is *referenced* to that standard.

In other communication industries where "standard measurements" are a way of life, there is something called "NBS Traceable Certification", which means that every piece of calibration equipment has a family-tree arrangement back to the original (and one and only) NBS (National Bureau of Standards) "standard". To the best of our knowledge, there is no 75 ohm CATV signal source on the market which has "NBS Traceable Certification". As an industry, we have a long way to go to be even equivalent in measurement technology to say the two-way communications industry, where *NBS Traceable Certification* often extends right down to the local radio service shop.

So *lacking* any *real* standard reference source (i.e. one that sits there perking away at 0 dbmv into a 75 ohm load, year after year, in a sterile atmosphere and constantly monitored by sophisticated also-certified measurement equipment), *how does the industry reference SLM/FSM instruments?*

The *hard microvolt approach* does employ an NBS traceable format. In the language of the NBS people, a hard microvolt is a microvolt of signal that is generated (and measured) following IEEE acceptable procedures, using only equipment that has traceable NBS certification. See Diagram 1. Here we have an NBS Traceable Certification 50 ohm signal generator source

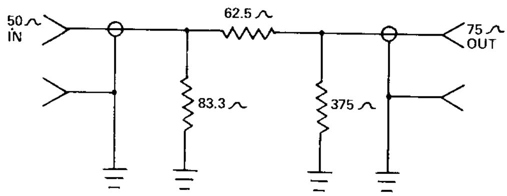


DIAGRAM 2

(i.e. as commonly employed in the two-way communication industry) as a source. Because it is 50 ohms and we are 75 ohms, we have installed a fixed-loss match pad between the 50 ohm output on the source and the 75 ohm input on our test equipment.

Oops!

Chances are we would lose our NBS certification by installing our non-NBS traceable match pad in the line.

Oh well, it was a good start anyhow.

Or, to take it a step further, a 50 ohm generator, with NBS tracings, is operated into a thermatically controlled power meter (also with NBS tracings), at 50 ohms and the output power of the 50 ohm source is verified first by the NBS traceable generator and then by the NBS traceable power meter (which compensates itself as a function of room temperature). Then it delivers the generator signal to our fixed loss match pad, which jumps up and bites our best intentions all over again.

Now, seemingly anyone with just a little care can build a fixed loss pad, as shown in Diagram 2. As a matter of fact, most anyone can. But unless we physically take that pad to the NBS in Boulder and get it certified, *we cannot produce NBS traceable calibration set ups* on 75 ohm CATV test equipment.

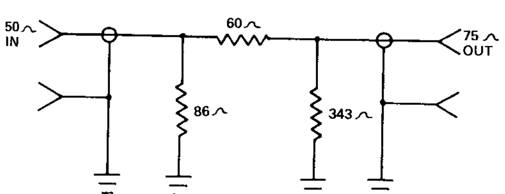


DIAGRAM 2-A

METER CALIBRATION SOURCES

An SLM cannot be calibrated utilizing a signal source other than 75 ohms (unbalanced). Unfortunately many, if not most, of the professional **power meter** equipment available today has been designed for the 50 ohm industries (two-way radio, etc.), and some allowance must be made for the 50 ohm source impedance.

When a 50 ohm source is utilized to calibrate an SLM, a fixed loss 50/75 ohm pad must be inserted into the line between the source output and the SLM input. Such a fixed loss 50/75 ohm pad is shown in Diagram 2 here.

A Hewlett-Packard Model 431A or B power meter, a General Radio 021-AV, Measurements Model 80, Hewlett-Packard 608A,or Boonton 202B are adequate sources.

The matching pad shown in Diagram 2 has 7.78 db loss (i.e. any levels out of the 50 ohm source will be 7.78 db lower at 75 ohms, out of the matching pad). The 6.0 db fixed loss pad shown in Diagram 2-A is slightly less accurate, but far easier for which to locate resistor values.

You are cautioned also to keep in mind that most RF signal generators are calibrated into an **open** circuit. When the generator (source) is operating into a **matched load** (i.e. the fixed pad shown here) the actual level present is **3 db lower** than the **indicated** output on the generator.

Therefore, into a matched 75 ohm load **through** the fixed loss matching pad shown here, a signal generator designed to operate into a 50 ohm open circuit will read 7.78 + 3.0 db or 10.78 db lower than indicated on the generator. Thus to set up an SLM for a 0 dbmv (at 75 ohms) measurement voltage, the 50 ohm generator is set for +10.78 dbmv output.

So, as a matter of fact, CATV test equipment is probably *not* very pure in the sterile world of VHF and UHF communication measurement equipment. In the two-way industry $500.00 frequency counters can trace their alignment parentage directly to the National Bureau of Standards, but in CATV $1,000.00 SLM's cannot.

We have run through this exercise to *amplify* the kind of position the industry *could be in* if a bunch of real measurement nuts got loose. As things now stand, we are on our own to make our own test equipment and procedures *function to the level* or quality which *our customers demand* of us.

This brings us back to the way we operate our distribution plants and head ends. As long as we do the job in a manner which gives others the impression that we do care and are trying to stay reasonably current with technology, we can probably avoid a bunch of measurement nuts pushing the FCC into *demanding* that we utilize equipment much more sophisticated than we now use.

The *message* here is that things *could get very complicated,* and in a hurry. FCC Field Office inspection of cable systems is just getting underway. For the *first time* professional Commission field engineers are making routine visits to cable systems. They are forming impressions of what they see, and these same field engineers travel from your stop to the two-way service shop up the street. You show them your 15 year old 704B (value—$200.00?) and that is your "test equipment". The two-way shop up the street, with two employees, has more than $10,000.00 invested in test equipment. The difference is pretty dramatic, and sooner or later it could catch up with us!

So one of the very *first* things every system in the country should do is at *least* invest in some system which makes verification of the single 704B you have in the shop more plausible than it now is. As an aside, we asked one system operator in Missouri how he knew his 727 was within factory spec. He replied, "I drive over to (name of town) and compare it against their meter" was his response. So we called the operator in (name of town) and asked him how he knew his meter was accurate to factory specs. "I check it against my pilot carrier generator at the head end" was his response. "But it has an output gain control on it" we noted. "Yeh, but it is pretty stable" he replied.

Well *pretty stable* may not be good enough. If your present meter system performs so well that you don't have cross mod on your system, you probably are of a mind to forget all about anything more elaborate than your meter and the trust you now have in it.

So let's explore how a more accurate meter might *pay* for the extra accuracy in a very short time. We all know and accept that plant amplifier gain is critical when you *approach* the cross mod intercept point. So it follows that

NBS? WHO ARE WE KIDDING?

Actually, the National Bureau of Standards main involvement in the two-way industry is in the area of **transmitter frequency accuracy.** In the two-way industry, the FCC is **very** sticky about licensed transmitters staying on frequency and that single measurement means more to the average two-way maintenance man than any other. Consequently, frequency meters (i.e. virtually all are frequency **counters** now) typically have traceable (to NBS) certification.

In CATV, the main area of growing FCC concern is with **signal levels.** It is **potentially** our industry's "frequency accuracy" measurement. Thus the day **may** come when through NBS the FCC establishes traceable certification procedures for signal generator equipment utilized for referencing field SLM/FSM devices.

The day is **not** here yet but it **may** come. Perhaps we can avoid that day by cleaning up our own act; on the other hand, after the recent picowatt fiasco, perhaps nothing we do will prevent that eventuality!

NBS — WE AREN'T KIDDING!

The capacity to require NBS traceable certification of signal generator "calibration standards" does exist.

One example of this is found in a news release from Micro-Tel Corporation of Baltimore. According to Micro-Tel, their **model GC-1280 signal generator calibrator has a precision resolution of 0.01 db traceable to the National Bureau of Standards** through a 1 kHz ratio transformer.

And the price of this machine? $24,500!

if you *never* have any cross mod, you are operating far enough *below* the intercept point throughout your plant that even with temperature and plant AGC variations, the plant never swings *up into* the intercept point. In effect, you run everything low enough that even with temperature and voltage and aging variations, you stay *out* of cross mod.

This means you are giving away, cumulatively, several tens of dbs of system gain capability. A 25 db gain line extender that is running at 22 db for safety's sake *gives away 3 db* of gain for safety. In eight amplifiers, you give away 3 db times 8 or 24 db of gain—roughly the equivalent of a full amplifier. That is money *you have tied up* in your plant that you cannot get out of your plant, and short of some tremendous cable aging, *you will never get to use.*

Now take the cost of that 24 db of gain you give away. It is the cost of an amplifier. It takes just about the cost of *one* line extender to equal the cost of *one* of the less expensive *SLM calibrators* now on the market. It takes the cost of just four or five extenders to equal the investment cost in a unit like the Sadelco 260-A Analyst.

If having one of these calibration references means the difference between operating your plant amplifiers more efficiently (and thereby saving total amplifiers in the overall system), or plugging along at reduced levels for safety's sake, *the clear choice should favor investing in a calibration reference system.*

How Accurate Is Accurate?

Because we are not in the NBS traceable arena, we have the problem of defining "what is accurate" and "what is not accurate".

Any SLM that has manual tuning compensation can be made to "compensate-calibrate" to needle-width accuracy but *only* for the *room temperature* in which it was calibrated. That is, given the range of the tuning compensator, and a "reference standard" the *tuning compensator can be checked monthly,* weekly, or daily against the *reference standard* and the compensation required noted as often as you like. Such a system will track to as close as you can eyeball the meter itself, allowing of course for meter range and temperature inaccuracies discussed in October, November, and December CATJ.

Any SLM without tuning compensation can be *mentally compensated* by the same technique. All that it requires is a small chart attached to the instrument, such as shown in Table 1 here. By incorporating the last "reference standard" date on the attached-to-meter chart, you also have a handy reminder date as to the length of time that has expired since the last "reference standard" procedure.

Now if you go through a *reference calibration procedure,* say once per week, what do we do about temperature and meter range (i.e. position on the scale) variations? *Temperature* is the toughest one to handle. There are plenty of techniques available (i.e. stick the unit in an oven at home and run it up to 120 degrees, make some readings, let it cool off, then stick it in a freezer and repeat the process),

TABLE ONE – REFERENCE FORM

Date Last Validation: ____________

Next Validation Req: ____________

Calibrate Frequency	Correction Factor
2	
3	
4	
5	
6	
94 MHz	
100 MHz	
106 MHz	
7	
8	
9	
10	
11	
12	
13	
Calibrate Ref:	
Calibrated by:	

which the average CATV system *could* do, but chances are you would not go to the trouble of doing this. Clearly, what is *really* needed is a new consciousness of the meter manufacturers. *Instead* of telling us "accuracy is +/— 1.5 db at 25 degrees C and +/— 3.0 db from -18 C to +65 degrees C", we need to have a graph packed in with the instruction manual that shows us the *exact* amount of *low* or *high* the meter reads for degrees of temperature above and below (say) "25 degrees C". If we had such a table or chart to work from, then you could make your own *mental* adjustments by noting that at 0 degrees C the meter reads low by 0.8 db, and then add 0.8 db (for example) to all readings obtained at zero degrees.

The *scale accuracy* problem is quite simply solved. All that is required is an external 1 db per-step pad; see Diagram 3. From our report on meters in the preceding three issues of CATJ, you have already determined that *in some part* of your meter's scale, *the meter reads close to accurate.* What you need to do to make accurate readings at the head end or along the trunk *where accuracy really counts,* is to make sure all readings you make are done *in that meter-scale-region where the accuracy is highest.* This is not always possible with the combination of 10 and 20 db pads built into the instrument. So you should invest in a *quality* 1 db step attenuator, from 1 db to 10 db, and *carefully* carry it around with you to use *ahead* of the SLM/FSM when making measurements. Between the 10/20 db step pads on the FSM/ SLM, and the 1 db step attenuator, you should always be able to get a reading in that portion of the scale where the meter accuracy is highest.

Let's assume you *were* to adopt a procedure for maintaining your own meters and verifying your own head end and plant level measurement integrity. How would it work?

Standard Reference Sources

For the purpose of this report, we have selected three commercially available standard reference sources to look at and review. They are variously called "FSM Calibrators", "Spectrum Analyst" and "Field Strength Calibrators".

Each employs a technique to develop a *standard reference signal* against which you calibrate your own SLM/ FSM. The obvious question is "against what do you reference your standard reference?". There has to be a little trust *someplace,* and this is a good place to start. We have seen that referencing to anything like the NBS standard is out.

1) 1 db step attenuators, such as Texscan Model RA734 (which is 1 db and 0.1 db steps), or Wavetek 7510 (1 db per step).

A reference source has to have several characteristics which we deem desirable. *Some* of these are (1) *Output accuracy* (i.e. if the instrument has either a fixed rated output or an adjustable and calibrated output level, you need to know the level it is supposed to be is really the level it is); (2) *Output stability* (i.e. if the output varies with time, temperature, or operating voltage levels, you have problems because the reference is no longer *referenced*); (3) *Frequency stability* (i.e. if the output frequency is user-adjustable, and if it drifts around in frequency while you are working on your SLM /FSM, the output on the frequency that the SLM/FSM is tuned to will vary as the "reference" moves in and out of the SLM/FSM i.f. passband); (4) *Repeatable accuracy* (i.e. if you go through the steps of calibrating on Wednesday, and follow it up on Friday, it would be nice to know that the reference you set to on Wednesday is the same reference you set to on Friday).

Of the three reference instruments we will discuss here two utilize *tuneable* oscillators. A tuneable oscillator is just what the name implies—a low power "transmitter/power (RF) source" which can be tuned across some band of frequencies. The third utilizes a single fixed oscillator which is in fact a form of internal self-referencing. *Any* oscillator circuit, whether free-running (i.e. not crystal controlled) or crystal excited (i.e. crystal controlled) have multiple outputs. An oscillator that operates *directly* at a VHF frequency (i.e. any frequency from 30-300 MHz) gets to the desired frequency by starting its oscillation at some *lower* frequency. It ends up in the VHF range through internal (self) multiplying, or after deliberately being multiplied from its initial oscillation

INJECTING

SIMULATED SYNC/VIDEO

It seems to CATJ that one way to settle the industry squabble about whether you align an SLM/FSM on an unmodulated (CW) carrier or try to utilize a modulated TV signal (which is difficult to get a reference level on) is for (1) **manufacturers of reference signal generators** to provide some simulated modulation capability for the reference signal generator; or, (2) for **manufacturers of SLM/FSM devices** to provide **accurate** alignment instructions for a CW carrier (which most of us utilize when referencing) **as it relates in their meter** to a similar RF voltage level signal **with** modulation present.

Perhaps a **separate** alignment input signal jack, for CW carriers, which would include just enough gain so that the user can reference to his 950 / 260-A / FSM/C-4 1,000 microvolt level, align his meter, and then, when switching to measuring real signals, as applied to the **normal** input signal jack, the meter automatically tracks to the special input jack compensated levels.

Of course CATV alignment personnel **could** simply align the meters against a +1 dbmv CW source, when they are really aligning for a **0 dbmv modulated TV reference level**, but that **assumes** that the meter **always** reads 1 db higher on modulated signals than it does on CW sources which is simply **not** true.

Perhaps an enterprising test equipment manufacturer will settle this one for us.

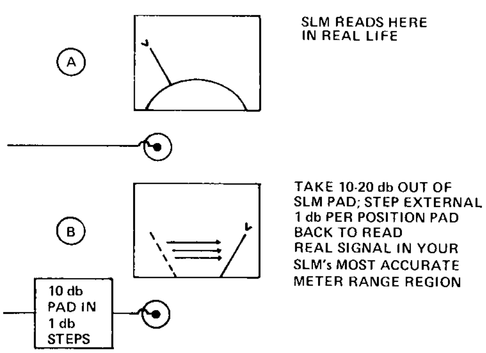


DIAGRAM 3

frequency to the desired frequency. Thus *any* oscillator has the *capability* of putting out (i.e. producing RF output) on more frequencies than just the desired output frequency. These additional (non-desired) output frequencies can be lower than the desired frequency, or, as is usually the case, higher than the desired frequency. Such extra outputs are also numerically related to the desired output frequency by some even or odd divisor or multiplier. For example, a 50 MHz desired output (oscillator) can also produce outputs at 1/2 the frequency (25 MHz), or twice the frequency (100 MHz). Virtually *every oscillator* ever conceived by man for the VHF region has outputs on more than just the desired frequency. The *amount* of output on undesired frequencies is *critical* with any standard reference oscillator signal source because when such a device is initially calibrated, it is done with a power meter measuring device that measures the sum of all RF power delivered to it, and that *includes any power that appears on the undesired frequencies* as well as the desired frequency.

So one of the things we wanted to determine was how much non-desired (i.e. harmonic or sub-harmonic) output signal did the various reference oscillator devices we were reviewing develop.

To do this we chose to utilize the Jerrold-Texscan VSM-1 Field Strength Meter, which is reviewed separately here this month. Because the VSM-1 is a modest form of spectrum analyzer, it allowed us to look for and measure output signals at not only the desired frequency, but also harmonic and subharmonics of the desired frequency. The three oscillator "reference sources" reviewed here were checked in that manner, and the results are reported separately here.

To check the output (frequency) stability, we simply ran the output of the oscillator into a frequency counter and let it sit for some time. The drift of the units was checked and reported as shown.

Output level accuracy is a tough thing to check *unless* you have some place to go for a really first class reference source. In effect, if you don't have a reference source to check the "reference source" you are sort of flying blind. Within the limitations of rounding up test equipment (i.e. 50 ohm sources with fresh traceable calibration) in the Oklahoma City area, we initially decided that this was one test we were going to have to by-pass. Yet the whole purpose of the three sources we are reviewing here is *first and foremost* the supplying of one (or more) *known reference levels*. So we cross checked each of the three reference source devices against each other (seemingly you might establish a mean that way), and against the Mid State SLIM and Sadelco FS-3SB, the two SLM instruments earlier reviewed which seemed to us to be the most accurate of those checked. The results are shown for each unit here.

Short term output stability was merely a matter of setting up and noting the indicated level changes over a one hour period for each instrument. We took each unit and ran its output into a four way splitter. The four way splitter drove the VSM-1, the Mid State SLIM, and the Sadelco FS-3SB and a frequency counter. We watched the wanderings within an hour's time (seemingly that is as long as you might be using the reference source at one sitting) and averaged the change as read by all three units.

Repeatable accuracy is quite another matter. Again, you are sort of on the spot unless you have a reference source and some method of determining the stability of the reference source-reference source. Lacking that, we made measurements over three weeks, and developed an (admittedly) *"gut feel"* for the degree of repeatable accuracy for each source. And we *label it clearly* for that; laboratory accurate it is *not.*

DELTA FSM/C CALIBRATOR

The FSM/C-4 is a small, light weight, easy to use portable signal generator. It operates from its own battery supply (Mallory manganese Mn 1604 is recommended) and provides not only a reference signal source for SLM calibration, but it also doubles as a marker generator (variable frequency) for equipment alignment, or as a signal source such as may be required from time to time for head end injection for Proof of Performance tests.

The FSM/C-4 is a tuneable oscillator covering the frequency range 54 to 250 MHz continuously. The output level is fixed (2) for calibration purposes, but of course it can be *lowered* from that (known) level by inserting a switchable or fixed pad between its output and the device to which it feeds signal. Delta rates the accuracy of the output to +/— 1.0 db.

There are three operator controls. An off/on switch performs the expected function. A meter-adjustment control will be covered shortly. A frequency tuning meter covers the range span from 54 to 250 MHz.

The unit has a front panel meter, and factory calibrated output levels for each of the video carrier frequencies from 2-6, 7-13. There are also spot output calibrated levels indicated for 90, 110, 130, 160, 230, 240 and 250 MHz. The factory calibrated output levels are marked on the front of the unit (see photo) much in the same manner Delta

Delta/Benco FSM/C-4, completely self-contained w/ internal 9 volt battery, is small enough to carry in the glove box.

marks tuning compensation settings on their FST-4 SLM unit.

The manual supplied with the unit says the normal output levels are in the range 5,000-6,000 microvolts (+14 to +16 dbmv). The unit supplied to CATJ for review had indicated output levels of 7,100 to 8,900 microvolts (+17 to +19 dbmv). Note again, that the actual output level for each video carrier frequency, or, spot frequency, is marked at the factory on the front of the unit. This is in millivolts (i.e. 8.6 mV = 8,600 microvolts) *not* dbmv.

In actual use you connect the output of the FSM/C-4 to the input of your SLM through a short (i.e. a few feet at most) length of RG-59/U. The SLM is turned on and allowed to warm up (Delta suggests 30 minutes for tube type SLM's). The SLM is tuned to some video carrier (or spot frequency) and the FSM/C-4 tuned to the same frequency.

Since most output levels in the FSM/C-4 range are in the +14 to +19 dbmv range, obviously pads on the SLM are put in to give a full scale reading of +20 dbmv. The meter-adjustment knob is now set so that the

2) The fixed output of the FSM/C-4 is established on the front panel for each VHF channel. It can be varied upwards by perhaps 2 db with the front panel "Meter Adjust" control (not recommended), and down by any amount you wish with the use of an external pad.

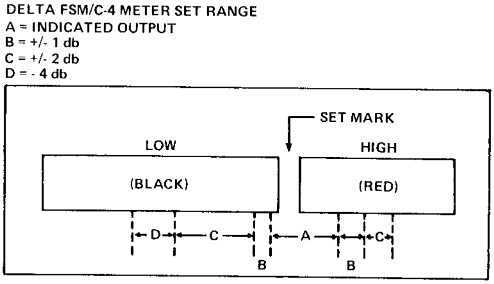


DIAGRAM 4

needle on the FSM/C-4 meter rests squarely between a black meter face area (left hand side) and a red meter face area (right hand side). A *silver colored stripe* there allows you to eyeball the needle until it covers the silver stripe. When you have done this, the output of the FSM/C-4 should correspond to the mV output level indicated on the front panel of the unit, for the channel on which you are.

Anytime you have to set some adjustable control to develop an output reading that is supposed to correspond to some factory calibration point, you naturally wonder how *critical* the control is. We checked this on the FSM/C-4 and the results are shown in Diagram 4. Note that the output fell off very quickly as we moved into the black portion on the scale, but stayed constant up to the "H" on HIGH on the red portion of the scale. Other level changes are shown up to +2 db (the point where the needle stopped moving, under the second "H" in HIGH), and down to -4 db under the "0" in LOW. In short, *if you are reasonably close to the silver mark*, you can rest *assured* you are close enough.

What *really* happens when the Meter Adjust control is turned, *more than the level changing*, is that the frequency varies. As the *voltage goes up*, the frequency *goes down*, and vice versa. You can deviate a few MHz either side of the nominal frequency by simply varying the voltage to the oscillator (with the 5K pot meter adjust).

The oscillator (a BF 184 transistor) is very straight forward and surprisingly stable mechanically. We dropped the unit several feet to the bench (sorry about that D-B-C!) and the frequency counter only flickered a few tens of kHz. The 54-250 MHz region is covered in one sweep, using the Mallory Inductuner—similar in principal to the unit found in the Delta-Benco FST-4 meter.

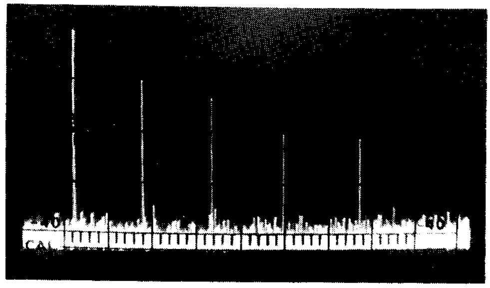
As you vary the output frequency of the unit, with the tuning control, the Meter Adjust control *must* be rezeroed for each new channel. The change is slight for adjacent channels, but sometimes substantial for several-apart channels.

Absolute frequency stability is not too much of a concern with most SLM units since the i.f. bandwidth of a typical unit is on the order of hundreds of kHz up to a half a MHz or more. So a unit with 0.1% frequency stability (+/— 0.211 MHz at channel 13 video) would *probably* still stay close enough for most broad SLM i.f. widths that drift during alignment and would *not* be a major concern. The short term frequency stability of the FSM/C-4 is very good. A short warm-up period is suggested by CATJ (a few minutes or so) as we noticed some instability vs. frequency for a few minutes, but, after that period, frequency drift is typically *under* 30 kHz per hour.

The panel meter monitors *RF output power*, not operating voltage. Through a diode detector (see Diagram 5) the 250 microamp meter reads detected output voltage. The output of the oscillator is "force-matched" to 75 ohms by R7 (75 ohms) tied across the output F fitting to ground. Because the diode detector in the meter circuit (D2) detects *all RF present*, it is reading *both* the intended output frequency RF signal level and any harmonics (or subharmonics) which might be present. When Delta does *their* calibration measurements for the front panel marking, they take into account any harmonic (or sub-harmonic) power content and *subtract* it before calibrating the front panel. Still, as the photo here shows, (feeding the FSM/C-4 output into the VSM-1) adjusting the desired frequency for a reference 0 dbmv reading produces a number of *harmonics* at multiples *above* the desired frequency. With the FSM/C-4 tuned to 55 MHz, we measured the second harmonic of 110 MHz as down 15 db, the third harmonic of 165 MHz as down 19 db, the fourth harmonic at 220 MHz as down 26 db, and the fifth harmonic at 275 MHz as down 26 db. For reference, the second harmonic at 15 db down is approximately 18% of the power of the desired; the third harmonic at 19 db down is approximately 11.5% of the power of the desired; and the fourth and fifth harmonics at 26 db down are approximately 5% (each) of the power of the desired. Adding it all up, the combined power of the second, third, fourth, and fifth harmonics sums to *39.5%* of the total power delivered by the *oscillator on the desired frequency.* We mention this, even though Delta says in their manual "Since the meter indicates total RF power (including harmonics), the true output at specified frequencies has been measured and is recorded on the front panel."

The +/— 1 db accuracy really works out to approximately +/— 970 microvolt accuracy at the indicated level of 8,300 microvolts specified for our test unit at channel 6, and this works out to +/— 11.7% accuracy. If the total output power is 8,300 uV (desired) +1,400 uV (2nd harmonic) +900 uV (3rd harmonic) +400 uV (4th harmonic) +400 uV (5th harmonic), then the sum of the desired plus the first four harmonics is really 11,400 microvolts or +21.15 dbmv.

Thus a small *initial* factory calibration error, in handling *even the first four harmonics* (2nd thru 5th) *could* result in an additional 1 to 3 db factory calibration error on the front panel.



Display on VSM-1 from FST/C-4 shows desired carrier (near ch. 2) and even and odd harmonics through 300 MHz.

We mention this not because we think it was necessarily true with the FSM/C-4 we reviewed and tested, but because harmonic output content in *any* reference oscillator can be an important consideration. The calibration procedures for any reference oscillator, utilizing a power meter as a calibrating device for the reference oscillator, must be compensated to cover (i.e. subtract) any harmonic content present. Even at 26 db down, a harmonic is 5% of the power content of a desired signal.

Summary – FSM/C-4

The Delta FSM/C-4 is a handy reference source. Based upon the accuracy of the unit we received for test, and the inability of our own testing procedures to reference the FSM/C-4 to an unflinching calibrated reference, we can only *surmise* by comparison checks that it may have not met the +/— 1 db

FSM/C-4 OUTPUT CIRCUIT WITH RF METER DETECTOR

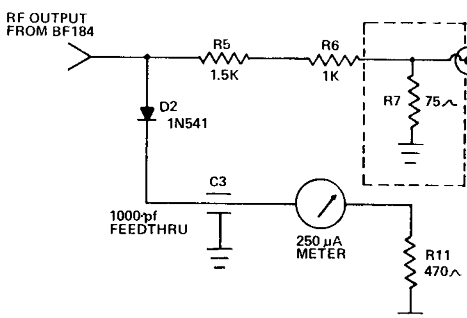
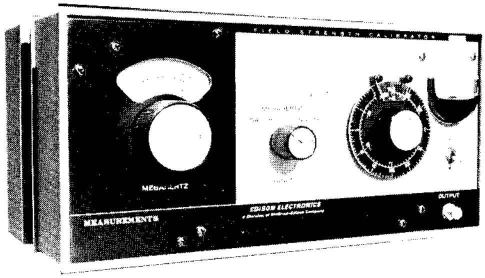


DIAGRAM 5



Measurements 950 signal generator is a highly precise approach to repeatable reference signal levels.

accuracy. It *appeared* to read approximately 1.5 db lower in *real* life than the front panel indicated level(s). We emphasize that this is a *"gut feeling"* however, and not a statement of irrefutable fact. As a cross reference standard for maintaining integrity *between* two or more SLM instruments in *your* system, *it will do just fine* even *if* it turns out to be slightly lower than spec. As a variable marker, it has numerous uses, and the price is certainly right!

MEASUREMENTS 950 FSM CALIBRATOR

Unpacking the Measurements 950, you are immediately impressed by two things—the operating controls are virtually self explanatory, and the manual looks thick enough to be Part 76!

The Measurements Corporation is a division of McGraw-Edison Electronics, Boonton, New Jersey. There are a number of Measurements instruments floating around in two-way communication service shops and the Model 80 signal generator by Measurements is about as common in that industry as the 704 is in CATV. In short, the Measurements people know measurements and have for many years.

The Model 950 covers the frequency range 54-250 MHz, in two switchable bands. Band one covers 54 to 115 MHz and band two covers 115 to 250 MHz. Unlike the Delta FSM/C-4 which has *one* calibrated output, the 950 has a wide range of continuously variable outputs that run the range from -70 dbmv (!) to +40 dbmv.

The unit employs a device called a *bolometer bridge* to control automatically the output level at the factory +/— 0.75 db spec. We'll talk about the bolometer bridge shortly.

The 950 has a pair of operator controls of note. There is also an on/off (power AC switch) and a band select control. One of the two controls *selects the operating frequency* for the signal generator, and it is claimed that the "hand calibrated frequency dial" is accurate to "+/— 0.5%". That works out to be approximately 1/4 MHz at channel 2 and approximately 1 MHz at channel 13. The individual TV channels (2-13) and (A-N) plus the FM broadcast band (calibration marks each 2 MHz) and common CATV pilot carrier frequencies (73 and 225 MHz) are scribed on the dial.

The other operating control is the *output level control.* Measurements notes that the *"+/— 0.75 db accuracy is at 100,000 microvolts output".* The output level control is calibrated in dbmv (in 2 db increments) and in microvolts (the calibration marks for microvolts varies from marks for 1/10th microvolt increments below 1 microvolt to marks at 10,000 microvolt increments in the 50,000/100,000 region). The fiducial for the output level control has *twin* markings, one that corresponds to the actual output level

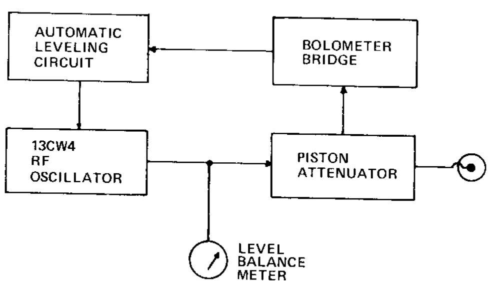
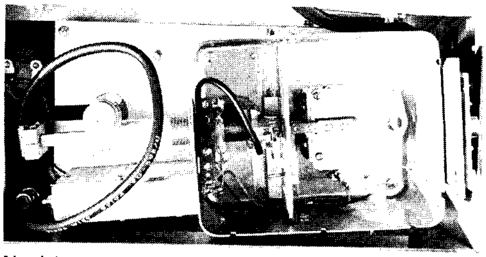


DIAGRAM 6

and another 6 db lower should you want to place a fixed pad between the 950 and the FSM/SLM you are calibrating.

The innards of the 950 are a little unusual, bordering on fascinating, if you "dig" sophisticated electronics and "microwave gadgets". The 13CW4 (Nuvistor) oscillator operates inside of a totally shielded container which is inside of the instrument case. As oscillators go, it is fairly straight forward and rugged. The tricky part is the use of something called a *"wave guide below cut-off mutual inductance attenuator"*. The *resonating inductor* in the 13CW4 oscillator *changes* (mechanically) from the low region (54-115 MHz) to the high region (115-250 MHz) and sits (when operating) *directly at the end* of a piece of 5/8's inch (O.D.) "pipe". The *output coupling link,* which is another coil connected to the output F connector, rides on a rod *inside* of the 5/8's inch "pipe". In effect, the output inductor for the 13CW4 *looks into* the 5/8's inch pipe and energy from the output inductor couples to the "link" by *traveling down the inside of the pipe* to the position of the link. The rod to which the link is mounted travels through the pipe and is controlled by the front panel knob that is marked in dbmv/microvolts. The *distance* between the output link and the output inductor on the 13CW4 oscillator creates a *known* (i.e. measureable)



Nuvistor oscillator tank circuit on 950 loads into a short section of pipe, functioning as form of wave guide for transmitting output frequency signal.

amount of attenuation and the *signal level appearing at the output F connector* is determined by that "distance". Because the output link, connected to the F connector, is only able to "see" energy from the output inductor *through* the small opening at the 13CW4-end of the pipe, stray pick up from the oscillator circuit is virtually eliminated, and the output appearing at the F connector is controlled by the shielding presented by the "wave guide operating below cut off".
See Diagram 7 here.

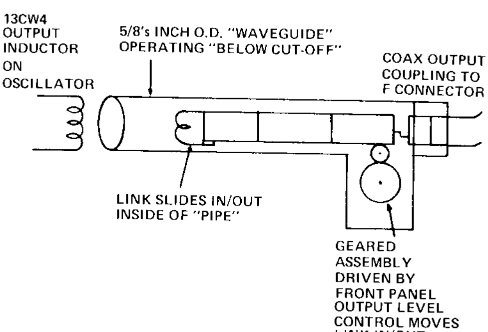


DIAGRAM 7

The output level is continuously monitored with a temperature compensated "bolometer bridge" through a signal sampling network at the output of the 13CW4. This sampled RF voltage is sent to an automatic leveling circuit which drives the automatic control circuitry *as well as* the front panel meter. The front panel meter is really a *security blanket* for the operator; it is marked only with a single mark that mark that reads *"Level Balance"*. As long as the needle points directly to the "Level balance" mark, the instrument's user has that secure feeling that the automatic leveling circuit is doing its job, and the output is within the Measurements' specification for the 950.

The extended low end range (i.e. down to 0.3 microvolts) deserves a passing comment. Measurements' considerable experience is in the two-way communications industry, where receiver sensitivities often go *down* to (and below) 0.3 microvolts. And where-as most hard number CATV measurements will *stop* at around 10 microvolts (i.e. -40 dbmv) this instrument goes on down to -70 dbmv. The extension of the range below useable CATV service levels is due to the *repackaging of the 950* from another Measurements machine intended for the two-way people *not* because Measurements does not understand the nature of the CATV measuring requirements. In effect, this instrument would be a fine service instrument for two-way people as well, although *they* would be forced to develop a technique of converting our 75 ohm 950 to their 50 ohm two-way gear to use it.

If this *suggests* to you that what Measurements has really done here is take a 50 ohm piece of gear and make it a 75 ohm piece of gear, to *save us the hassle* of converting 50 ohm outputs to 75 ohm outputs through the techniques discussed earlier here (see Diagrams 2 and 2-A), *you are right.* Of course in the process, they also calibrated it in measurement increments (both output levels and frequencies of interest) to correspond to our industry.

950 Performance

We are a little "bothered" by the spec which notes that the 950 output level is accurate to within "+/— 0.75 db *at 100,000 microvolt* output". Since they make a point of this, we naturally are curious *what* happens to the "+/— 0.75 db accuracy" at say 1,000 microvolts output, or 10 microvolts output.

In the two-way industry, where Measurements gear is better known, the area of critical measurements is at the bottom end (i.e. corresponding to 0.3 microvolt output on this unit). That is where two-way receivers are aligned and checked before release; the sensitivity of a two-way receiver for X number of db of quieting is the screw on which the two-way industry turns.

In CATV, we are concerned about measurement meter accuracy over a much *wider* range, but we are most concerned *at amplifier input and output level ranges* (see table in November CATJ, between pages 8 and 9). A few db off *at subscriber drops*, or head end input levels (both of which fall at or below +15 dbmv typically and may be much lower) just isn't that much of a life and death matter.

We would like to know from Measurements whether the "+/— 0.75 db accuracy" holds down to say 0 dbmv (1,000 microvolts) and, if it does not, what the accuracy of the signal generator is in this range.

If you have read through the first three parts of this FSM/SLM series, you are already aware that we utilized the 950 as a signal reference source for absolute level measurements at 0 dbmv. We presented test results using this as a source, "as *if* we knew the source to be completely dependable" at that range. We did this after hand carrying a Mid State Communications SLIM from the Mid State calibration set up at their factory in Indiana to Oklahoma City, knowing what the factory calibration procedure had shown for the instrument we reviewed in December CATJ. In effect, the Mid State SLIM became a portable reference between Beech Grove, Indiana and Oklahoma City, against which we checked the 950.

That *may* be a little backwards, but it gave us more *"75 ohm confidence"* than we could develop locally in Oklahoma City with 50 ohm "standards" generally available. And it gave us a cross reference system against the 50 ohm standards which we did have available here.

We made checks of the 950 output, suitably cross referencing our sources, and came to the determination that the 950 *does in fact* meet its "+/— 0.75 db accuracy" spec over a wide output range from -30 dbmv to +40 dbmv, *except perhaps* on low band outputs in the *factory reference* +40 dbmv range See table below.

MEASUREMENTS 950 REFERENCE CHECKS

Ch.	Panel (950) Set Lvls	-30	-10	+10	+40
2	Ind. Lvl	-30	-10	+10	+38.7
6	Ind. Lvl	-30	-10.1	+10.2	+39
7	Ind. Lvl	-29.7	-10	+10	+40
13	Ind. Lvl	-29.6	-10	+10	+40

In the -10 to +10 dbmv region, the 950 appears to be an extremely accurate device. It is well within its own spec in the low level (-30 dbmv) region as well. When you allow for the *potential* errors of the multi-cross-checking system utilized for developing a reference for our test purposes, it is *entirely possible* that the *real* error on low band (channels 2 and 6 indicated above) *may be within the -0.75 db spec,* even though *our* own tests indicated it *fell out* by as much as -1.3 db at +40 dbmv.

The piston attenuator control comes to a mechanical stop (i.e. it cannot be turned past) at +40 dbmv. There is no "knob play" *above* the dial marking for +40 dbmv. A very small error at the factory in the "balancing network" could account for the small error we found.

As a frequency meter, we found the 950 tracked within their own 0.5% spec (*within* the limits of interpreting their own dial scale markings) up through the middle of high band. When we got to channel 9 the dial markings for 9 (individual channels are "blocked on the dial"; there are *not* individual marks for each channel's visual or visual and aural carriers) we began to feel uncomfortable. By channel 12 we were setting the 950 to the approximate position of channel 11 aural to produce a carrier on channel 12 visual. At channel 13 we were setting to the approximate position of channel 12 color. This appears to be a temporary thing, for by the time we got to J (just above 13) we were almost back into the "J" panel marking; and by "K" we were back where we were supposed to be, up through "N" (where the 950 reaches its own high frequency end).

SADELCO 260-A ANALYST

Our third and last reference source instrument for this review is the Sadelco Model 260-A Spectrum Analyst. The Analyst actually is a more complex piece of equipment than either the FSM/C-4 or the 950 signal generators, and it has versatility far beyond that of either. We are going to deal *only with the RF generator functions* of the Analyst at this time.

For the record, the Analyst allows you to (1) *Calibrate* FSM/SLM devices, (2) *Measure* gain, loss, and response of an amplifier, (3) *Measure* return loss and VSWR, (4) *Determine* the location of cable opens or shorts, (5) *Measure* the noise figure of plant amplifier equipment. It does all of these things (and a few more) with an FSM/SLM (i.e. *without* a scope, detectors, bridges, etc. external).

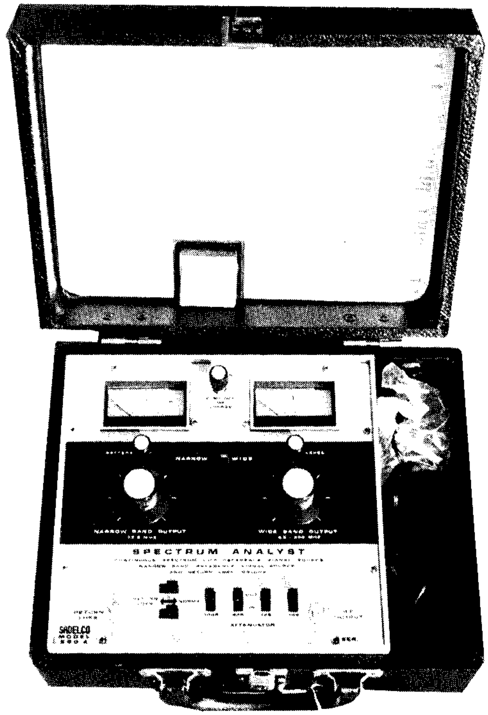
MEASUREMENTS 950

HARMONICS/STABILITY

In spite of the elaborate "mil spec" type approach to the manual on the 950, there is some pertinent data missing. We found no reference to the **harmonic suppression,** for example but measured the 2nd harmonic of 55 MHz (when desired was set there) at 42 db down; the third harmonic of 55 MHz at 45 db down; the fourth harmonic at 46 db down; and the fifth harmonic at 48 db down.

We also found no reference to **frequency stability** in the manual but measured one hour drift at approximately 10 kHz, at 83 MHz.

And we found no reference to **RF output** (signal generator) **stability** but found no measureable drift in level amplitude within a one hour measurement period.



Sadelco 260-A analyst has built-in battery charging system w/ narrow and wide band signal generators.

A thorough review of these Analyst functions will appear in the March or April issue of CATJ. At that time we will go into the theory of operation of the unit, and its design parameters. We will limit the discussion here at this time to the functions which are useful for setting up an FSM/SLM for reference measurements (i.e. the signal generator function).

The Analyst approaches signal generation from a different direction than either the FSM/C-4 or 950 generators. Both of the earlier-reviewed units generate a single carrier on a single frequency, and the user operates a tuning knob to place the desired carrier on the proper frequency.

The Analyst develops two signals; one is a crystal controlled *"reference source"* at 73.5 MHz. The other is a *"wide band white noise source"* that covers 4.5 to 300 MHz. The 73.5 MHz carrier has several purposes, and one of these is to provide a reference *for* the (wide band noise) reference. Very few FSM/SLM units will be aligned (i.e. set up for absolute level readings) at only 73.5 MHz (the frequency of the crystal controlled carrier). By designing an oscillator circuit that is *not* tuneable, some extra care can be put into the precision of the 73.5 MHz carrier level circuits. By supplying suitable voltage and level referencing systems, the 73.5 MHz oscillator maintains an accuracy of "+/— 0.25 MHz" according to Sadelco.

The mode commonly utilized for *FSM/SLM alignment* and referencing is the "wide band white noise source" which, with suitable cross referencing, is also "accurate to +/— 0.25 db" over the range 4.5 to 300 MHz.

In the white noise mode (Sadelco calls it the "wide band output"), the generator emits pure noise, at a known level, over a wide frequency range. This is similar (in practical end results *only*) to a sweep source, except that a sweep oscillator varies its output frequency continuously, as a function of time, and it moves fast enough that it "appears" to a meter or scope (through a detector) that it has a simultaneous output over its operating frequency range. In the wide band "white noise" scheme, *the noise is in fact* continuously generated over the full bandwidth *simultaneously.*

When you set up an FSM/SLM for absolute meter accuracy using a signal generator that has a single frequency carrier present (i.e. a CW carrier such as the FSM/C-4 or 950 generate, or as the Analyst generates on 73.5 MHz), the relative "width" of the carrier versus the bandwidth of the FSM/SLM is of no concern. The FSM/SLM expects to "see" one carrier and the generator supplies that *one* carrier. The detector circuit in the FSM/SLM detects that one carrier, and everything comes up the way the FSM/SLM manufacturer intended.

However, when your reference signal source is a *wideband noise*, as opposed to a narrow band CW (or modulated) carrier, the detector in the FSM /SLM "sees" the noise component of not just the desired frequency, but of all adjacent frequencies *passed to the detector by the bandwidth of the FSM/SLM*. See Diagram 8.

Then there is the matter of 0.5 MHz i.f. bandwidth. This would be a Sadelco, Blonder Tongue, Delta-Benco or Jerrold 727 kind of meter. When the FSM/SLM has a *tighter* i.f. bandwidth (i.e. the Mid-State Communications SLIM or Arvin 500B), the operator would normally compensate for the narrower (or wider) i.f. bandwidth. A *tighter* (narrower) *i.f. bandwidth* sees *less white noise* than the 500 kHz i.f. bandwidth and a wider bandwidth i.f. sees *more* white noise than the reference bandwidth. For a constant level noise source, 1 MHz i.f. bandwidth will see 3 db more noise than the 500 kHz bandwidth, and a 250 kHz i.f. bandwidth will see 3 db less white noise than the 500 kHz bandwidth.

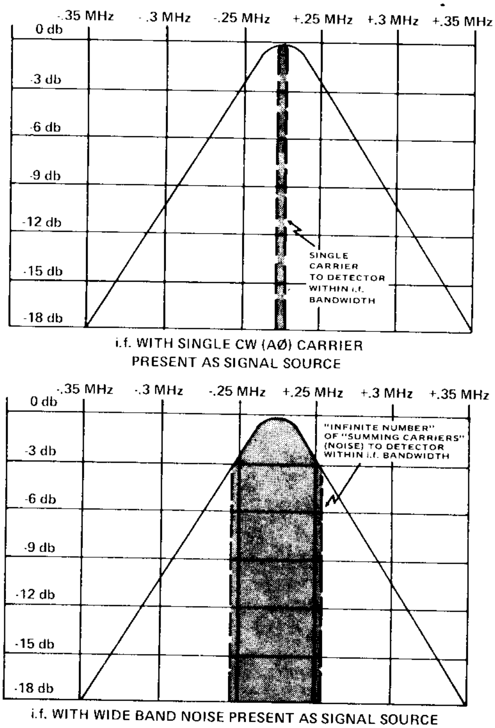
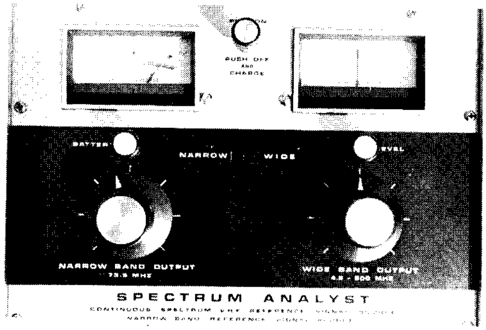


DIAGRAM 8



The Sadelco 260-A has separate function checks for operating voltage, narrow band CW reference carrier, and wide band noise generator.

The output level of the 73.5 MHz crystal controlled oscillator is fixed at 1,000 microvolts (0 dbmv) and by following two simple set up adjustments, its output is accurate to +/— 0.25 db. Switching the 260-A to the wide band noise position, a series of step attenuator pads (1 each 10, 6, 3 and 1 db) are brought in (at the output of the unit) until the FSM/SLM reading from the wide band noise is the same as the crystal controlled reference oscillator. By this simple procedure the 260-A is compensated for the particular i.f. bandwidth of your FSM/SLM and you may then proceed to make FSM/SLM checks across the spectrum. Because the noise output covers the full range of your FSM/SLM, after the initial referencing to the internal 73.5 MHz oscillator, *no further adjustments are necessary* to the 260-A. The *maximum* output (unattenuated) of the 260-A in the wide band noise mode is typically +10 dbmv, although it depends to some extent on the i.f. bandwidth of the FSM/SLM.

Other specifications of the 260-A are (1) *output match* 1.1:1 or better, (2) harmonic output minus 35 db (we *measured* the 147 MHz second harmonic as *down 32 db* and could not find a third or fourth harmonic down to a point 40 db below the 73.5 MHz signal), (3) maximum continuous use time is 6 hours on wide band output and 36 hours on narrow band output, (4) charging time is 10 hours with 50 mA of charging current at 22 volts.

The 260-A is *slightly* temperature sensitive according to the Sadelco specs. It has *negligible* spec variation when operated from 60 degrees F to 85 degrees F, but may have output variations as great as +/— 0.5 db at 32 degrees F and 100 degrees F. *We think it might be useful if Sadelco told us* (1) which way (i.e. minus or plus) the output level accuracy goes when it is 32 degrees F, or 100 degrees F, how much it deviates for ambient temperature changes and, (2) whether the +/— 0.5 db variation at 32 degrees F or 100 degrees F is in *addition to* the +/— 0.25 db unit accuracy (*therefore making it +/— 0.75 db*), or *in place of* +/— 0.25 db (*therefore making it a total of +/— 0.5 db*).

Finally there is the matter of *detector efficiency* (or "reaction") to white noise signal source(s). As we have explored in some detail in previous parts of this series, the peak reading detector tends to *read higher with modulated TV signals* than with unmodulated carriers. The difference between the two is in the worst case approximately 1 db and *some* meter manufacturers split the difference when aligning a unit. And how does a peak reading detector react to white noise? It tends to read *closer to the level reading found with a modulated TV signal* than an unmodulated carrier. However, when using the Analyst, since you reference with an unmodulated 73.5 MHz carrier, and set your wide band noise output to *correspond to that same 1 millivolt level* on your FSM/SLM, you *may* be setting the FSM/SLM to an absolute level that is some part of a db (perhaps up to 1.0 db) lower than you would if you had an exact (known) 1,000 microvolt *modulated TV carrier* with which to reference.

See The Crud

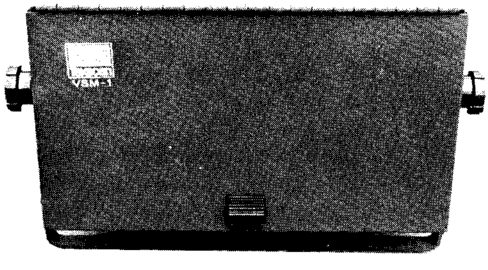
CATJ REVIEWS THE VSM-1

The Jerrold/Texscan Model VSM-1 *field strength meter* departs from the normal FSM/SLM type of device in that it displays the received signal level on a CRT (cathode ray tube) rather than on a pure meter. Where the normal FSM/SLM is able to display only a single carrier at a time (on the meter face) the VSM-1 is capable of displaying an almost infinite number of carriers simultaneously. In fact, the number of carriers to be displayed at a single instant is totally in the hands of the instrument operator; one or more is the order of the day.

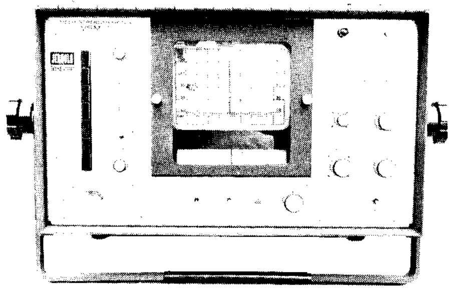
Jerrold/Texscan call this a *field strength meter*; the manual refers to it as a field strength meter; and large clear lettering on the front panel proclaims it to be a *"field strength meter"*. Yet, anyone viewing the instrument for the first time has the clear gut feeling that he is looking at a spectrum analyzer. It functions like a spectrum analyzer; it has controls like a spectrum analyzer; it displays like a spectrum analyzer. Still, if Jerrold/Texscan want to call the VSM-1 a *"field strength meter"*, far be it for us to argue the point.

Reviewing the VSM-1 could have been approached from one of two different directions. We could approach it as a spectrum analyzer, or as an FSM/SLM. We chose the latter, not wishing to argue with the nomenclature imprinted on the front panel and throughout the manual.

As a field strength meter/signal level meter, the VSM-1 has a number of unusual features. The multiple carrier display (simultaneously) is the most impressive of these points. Anyone who has spent *even thirty minutes* balancing a plant, aligning levels at a head end, or setting signal traps knows the inhuman effort required to end up with *all* of the desired carriers in the proper balance and ratios. Time spent moving back and forth from carrier to carrier, readjusting meter compensation, and repeaking the tuning knob on



Jerrold/Texscan VSM-1 field strength meter self-protects from environment.



VSM-1 front panel upon casual inspection looks to be complicated to program; it is not.

JERROLD/TEXSCAN VSM-1

Frequency Range: 4 to 300 MHz
Measurement Range: —40/+62 dbmv
Dispersion:
30 kHz/30 MHz per division, variable
Input Impedance: 75 ohms
Frequency Accuracy:
+/— 3 MHz; +/— 1 MHz
50-90 degrees F
Resolution:
i.f. bandwidth 200 kHz at 3 db points
Attenuation: 0-62 db in 1 db steps
Display Size: Approximately 2" x 4"
Sweep Rate: Variable 2 to 30 Hz
LOG Scales: 20 and 40 db
Temperature Range: 0 to 120 degrees F
Power Requirements:
Internal rechargeable
12.5 volt battery; accessory 110 VAC supply/charger
Weight: 20 pounds with batteries
Size: 8" x 13" x 10.5"
Price Range: $1,625.00

each carrier often *far* exceeds the time spent *making the actual equipment adjustments*. Seemingly, anyone who could show the CATV industry a quicker, easier, and potentially more accurate way to set levels and balance equipment would have the proverbial mouse trap in hand.

Still, there have been "spectrum analyzer type boxes" in CATV for a number of years, and for *pure field use* they have not caught on. Perhaps we should try to analyze why, since the concept of multiple-carrier display (simultaneously) seems too good to pass up.

Until the VSM-1, most (*if* not all) spectrum analyzer type boxes have been (1) bulky, (2) expensive, (3) heavy, (4) delicate, (5) somewhat complicated to use, and (6) they required a ready nearby source of 110 VAC.

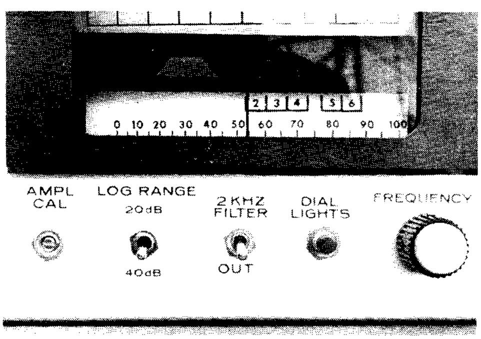
Comparitively, the VSM-1 is (1) *not* bulky (it measures 8" by 13" by 10.5"), (2) *not* expensive (it lists for $1650), (3) *not* heavy (it weighs 20 pounds including internal battery), (4) *not* delicate (compared to a 727 it *is* delicate; compared to a Tektronix 7L12 it is *not*), (5) *not* complicated to use (compared to a Sadelco FS-3SB it *is* complicated; compared to a 727 it is *no* more complicated), and (6) does *not* require 110 VAC to operate (it has an internal rechargeable battery that provides 2.5 hours of continuous use).

Any piece of test equipment has to be a logical replacement for time. That is, it must do things that need to be done, and it must do them quickly-preferably quicker than other units or techniques available to the user. Finally, it must do these things accurately, and for a price which balances mentally in the mind of the potential buyer/user as a fair trade for the dollars it costs.

Approaching the VSM-1 as a field strength meter, we have run it through the same tests by which the previous five instruments (see November, December CATJ) were tested. The results will follow. Because we felt that the VSM-1 has uses that go beyond the mere measurement of absolute and comparitive levels, we discuss these as well.

How It Works

Explaining the complete technology behind the VSM-1 is clearly beyond the scope of this review. However, note in



Strip frequency dial chart, directly under CRT display, reads out frequency in TV channels or MHz.

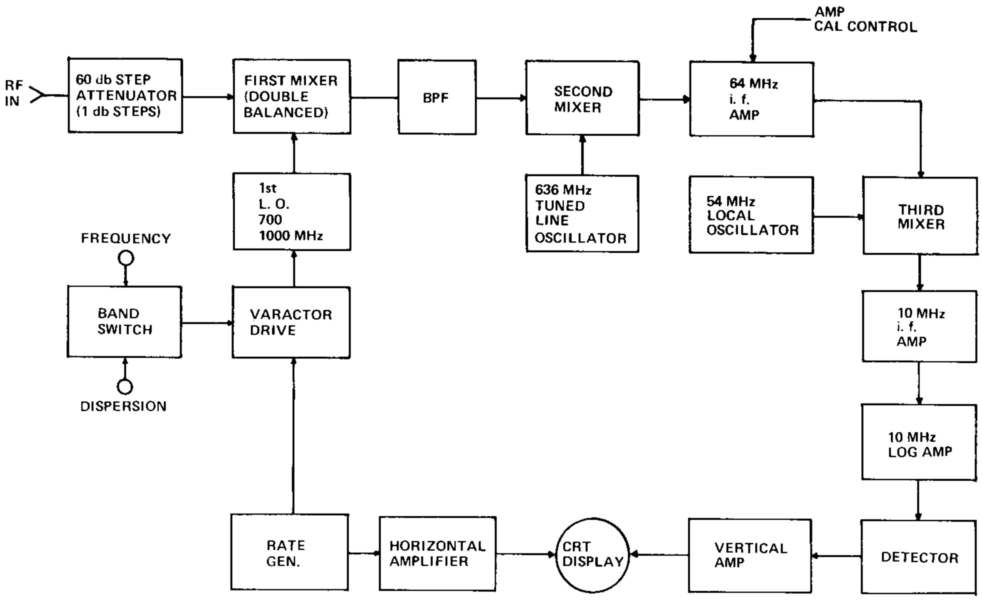


DIAGRAM 1

Diagram 1 that the first section the input signal sees is a step attenuator (0-62 db in 1 db steps). Following the step attenuator is a double balanced mixer which is driven by both the input signal from the attenuator and a voltage tuned local oscillator operating in the 700-1,000 MHz region. The double balanced mixer uses four matched Schotty-barrier diodes in a format known as a "ring modulator". Note that there are *no* tuned (i.e. frequency selective) circuits *ahead* of the double balanced mixer. This means *the sum* of all RF voltages present at the input F connector is delivered to the double balanced mixer. The manual for the VSM-1 notes several times that, *"The input to the attenuator must not exceed 1 watt average and the input to the double balanced mixer (i.e. output of the attenuator) must not exceed +20 dbmv average."* This is repeated often in the manual, indicating a concern on the part of the manufacturer that should you pump too much RF into the VSM-1, you will "blow" the diodes in the ring modulator (i.e. first mixer). At most normally encountered CATV levels, even with twelve channels running directly out of the head end, there is little chance that you will get into difficulty with the maximum input allowed, *provided you operate the VSM-1 with input pads in to start with.*

The output of the first mixer runs through a bandpass filter and into a second mixer. This one is driven by the 636 MHz (center frequency) second local oscillator. The product out of the second mixer is a 64 MHz i.f. where the *first* gain is encountered (an IC amplifier). The front panel "AMP CAL" control is tied to this stage.

Following the 64 MHz i.f. amplifier is yet a third mixer. This one is operating to produce a 10 MHz i.f. output after being driven with a 54 MHz local oscillator. At 10 MHz there is another gain stage, which is followed by a 30 db log amplifier. The output of the 10 MHz i.f. stage *ahead* of the log amp is split between two parallel limiting IC amplifier stages which drive the log amp(s). The two log amp paralleled stages are *summed* in one differential output, and drive the detector stage.

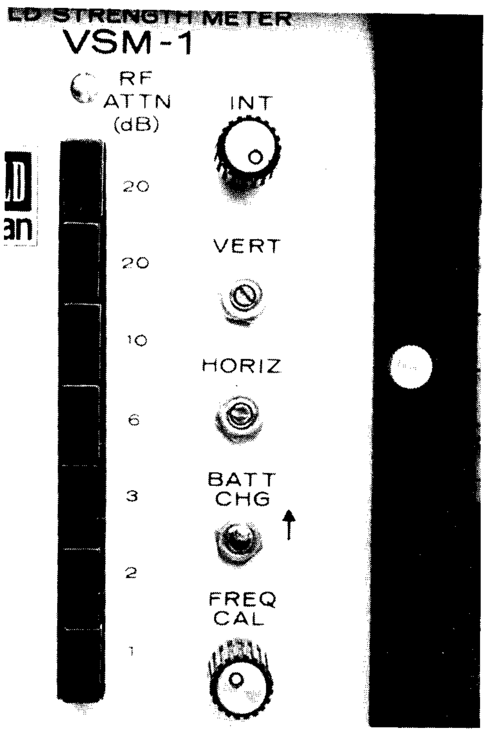
The detector input has a wide band differential input and differential output IC amplifier. Each output drives hot carrier diodes used as linear detectors. The two detector outputs are *added,* and the sum of the two drives the vertical amplifier for the CRT display (the vertical amplifier is the device that produces the vertical display of signals relative to input amplitude). On the front panel a LOG RANGE switch selects either a 20 db or a 40 db log display range. Finally, the vertical drive voltage(s) goes through a vertical amplifier, utilizing a pair of transistors operating as a complimentary pair. A more detailed analysis of the VSM-1 circuitry can be obtained from Jerrold or Texscan.

Some attention should be given to the power supply circuitry. The primary voltage for the VSM-1 is an internal 12 (12.5) volt battery. There are four regulated low voltage supply lines: 11.3 vdc, 10.5 vdc, 9.85 vdc, and 5.0 vdc. Normally the VSM-1 will be utilized with the internal battery, although it is hard to get along without an accessory charger/AC mains power source. The rechargeable batteries will operate the VSM-1 for 2.5 hours of continuous use per charge. At full charge the cells carry 12.5 volts and are considered discharged at 11.5 volts. Recharge time is approximately 14 hours.

On the bench, operating from the accessory charger/AC mains supply, the unit can simultaneously be charged and operated. The 2.5 hours continuous use field time seemed like a poor trade to us, until we spent several days with it in the field. In the course of a couple of 10-12 hour days, we never ran the battery down, even though we spent one day completely aligning a twelve channel head end with the VSM-1, and another day firing trunk and distribution line amplifiers for a new plant section. In actual use you tend to spend so much less time setting up equipment with the visual display, than you do with a standard FSM/SLM, that the *actual unit on time is cut considerably.* In our view, the 2.5 hour continuous use time is adequate for most purposes, except perhaps tedious head end trouble shooting, and there you have 110 VAC available to power the unit.

The Display

The display is on a CRT that is approximately the same size as the 5 inch CRT in a Sony KV-5000. The vertical and horizontal drive sections of the VSM-1 limit the display area to approximately 2-5/16 inches in height by 3-11/16 inches in width. The graticule covering the CRT display has 6 vertical divisions and 10 horizontal divisions. With the unit set up *the way the factory recommends,* you have approx-



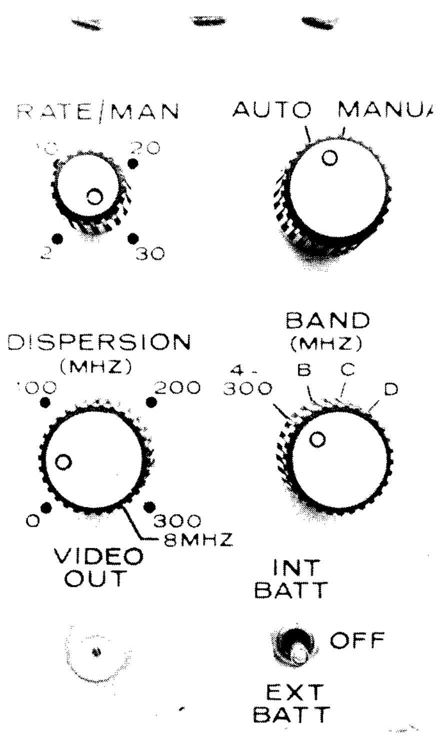
Push button attenuators on VSM-1 select to 62 db of front end attenuation, in 1 db steps.

imately 5.25 vertical divisions (of calibrated display) and 8 horizontal divisions.

Since amplitude is the major measurement factor, vertical scale markings on the graticule are of interest. In the 20 db LOG RANGE position, the display is calibrated in 1 db divisions along the center vertical line. In the 40 db LOG RANGE position, the same display marks are 2 db per mark divisions. Because the dispersion (i.e. horizontal frequency spread) is adjustable by the operator there are no horizontal calibrated marks on the graticule.

Operation

You set up for operation in much the same way you would any other *"field strength meter"*. The input signal(s) is connected to the input F connector, and an appropriate amount of input pad is pushed in on the push button



Main controls effecting absolute accuracy of VSM-1 readings are clustered at lower right of front panel.

attenuators so as to keep the display on the CRT face. Remember the warning that dumping too much RF into the input (in excess of +20 dbmv beyond the input pad) may result in damage to the first mixer stage.

Next the frequency of the desired frequency carrier is dialed up. The dial which displays frequency is under the CRT display and consists of a long tape which winds around in front of a long horizontal window (see photo). At any one time you are visually seeing approximately 100 MHz of dial calibrated tape.

With the VSM-1 in the 40 db LOG display, a signal that comes to the top horizontal graticule line is 0 dbmv with all attenuators out. With the VSM-1 in the 20 db LOG display, a signal that comes to the top horizontal graticule line is -20 dbmv with all attenuators out.

In either the 20 db LOG range, or the 40 db LOG range, the actual level of the signal you are displaying is the base amount (-20 or 0 dbmv) *plus* the amount of the attenuators you have plugged in, less the amount below the top graticule line. As noted previously, the vertical center line on the graticule has calibration marks which are in 1 db steps on the 20 LOG range, and 2 db steps on the 40 LOG range.

Calibration

Anyone who has utilized a spectrum analyzer type of machine knows that one of the inherent problems with most SA devices is the *accuracy* of absolute measurements, *as a function of dispersion.* With an SA, dispersion is basically the control you have over the frequency *width* of the display. With the dispersion knob, you control whether you are displaying a narrow segment (i.e. a single carrier, such as the video carrier) or a wide segment (i.e. the full range of the instrument from 4-300 MHz) on the CRT. With the

VSM-1, as with many other SA devices, the vertical height (i.e. the relative RF signal voltage) *does not stay constant* (i.e. reading the *same* level on the calibrated CRT display) as the dispersion control is changed from a wide display to a narrow display (or vice versa).

The dispersion control on the VSM-1 is calibrated (roughly) in increments of 300 MHz, 200 MHz, 100 MHz, and 0 MHz. There is also a locked-in dispersion display of 8 MHz, which happens to be just about right for a single channel display. We wanted to find out how much the display vertical height (the RF voltage measurement) *changes with dispersion*, so we set up a single channel 13 carrier from the Measurements 950 signal generator as full scale on both the 20 LOG and 40 LOG scales. The results appear below.

20 LOG SCALE

Channel 13 visual AØ Carrier
Level -20 dbmv (full scale)

Dispersion Setting	Indicated Level
8 MHz *	-20 dbmv (Ref.)
300 MHz	-36 dbmv
200 MHz	-35 dbmv
100 MHz	-29 dbmv
0 MHz	-19 dbmv

40 LOG SCALE

Channel 13 visual AØ Carrier
Level 0 dbmv (full scale)

Dispersion Setting	Indicated Level
8 MHz *	0 dbmv (Ref.)
300 MHz	-5.5 dbmv
200 MHz	-2.0 dbmv
100 MHz	0 dbmv
0 MHz	0 dbmv

*Locked-in dispersion position

Thus, the VSM-1 gives its most accurate absolute level measurements (i.e. readings) in the 8 MHz dispersion mode, for either the 20 LOG or 40 LOG display, or in the narrower (100 MHz to 0 MHz) dispersion setting for the 40 LOG display.

Then there is the matter of sweep rates. Again, a *difficulty* encountered with virtually any SA device is the *accuracy of levels displayed as a function of the sweep rate.* Keep in mind the display is created by sweeping an oscillator across the intended spectrum (in this case all or some part of the range 4-300 MHz), and wherever the sweeping oscillator encounters an RF voltage (on a particular frequency), it produces a vertical (line) display on the CRT. The sweep rate is simply a control that determines whether the sweeping oscillator "goes by" the carrier in question twice per second (slowest on VSM-1), or thirty times per second (fastest on VSM-1).

Every operator of an SA has his own favorite sweep rate. The VSM-1 manual makes the notation that, *"For maximum accuracy* (of absolute levels) *the product of the RATE/MANUAL setting and the DISPERSION* (MHz) *setting should be less than 3000."* What they are saying is that absolute accuracy, within the spec of the VSM-1, is a *combination* of how many times per second the sweeping oscillator "goes by" the carrier in question, and the width of the total display. A slow moving sweeping oscillator that has to track over a full 300 MHz range obviously has a lot of ground to cover, and the end product, a vertical display, stays inside of the VSM-1 i.f. bandwidth for only a short period of time. On the other hand, a fast sweep rate going over a narrow portion of the spectrum goes by the intended carrier for display much more often.

So when you have the DISPERSION control set to 300 MHz, and the RATE control set at 30 sweeps per second, the product of the two is 300 x 30, or 9000. Based upon the somewhat complicated logic of the i.f. bandwidth and the P4 CRT phosphor, plus the scanning rate and the swept bandwidth, that is far *too much product* to result in accurate measurements. The VSM-1 manual tells you this and suggests that you keep your dispersion/rate product below 3,000 for maximum accuracy.

This works out to the following:

Dispersion Setting	Maximum Scan Rate	Product of both
300 MHz	10 Hz	3,000
200 MHz	15 Hz	3,000
100 Mhz	30 Hz	3,000

Bands B, C, D

A four-position band selector switch on the front panel offers the user the opportunity to have full manual tuning of dispersion and frequency tuning (with the manual tuning calibrated tape in the window), or three separate user-set pre-programmed dispersions and ranges.

Positions B, C, and D are front panel set by the user for the exact swept frequency display and dispersion he wishes. There are two adjusting screws for each band, and it takes just a couple of minutes to program them for your favorite needed portion of the spectrum.

We programmed band B for coverage from 54-88 MHz (which is a 34 MHz wide spectrum or dispersion that we can utilize the fastest 30 Hz scan rate in and still stay well inside of the 3,000 product maximum), band C for 174-216 MHz (which nets a 1260 "product" for 30 Hz display), and band D for 54-216 MHz (which to stay within a 3,000 product requires a scan rate of not over 18).

The handiness of the pre-programmed bands is this: If you are checking for head end or amplifier tilt (or flatness), you can switch to pre-programmed band D, set the scan rate to 15-18, and immediately see the full 162 MHz from 54 to 216 in a single display, and know without additional control tweeking that the display is as accurate as the VSM-1 can provide. If you need to zero in on either high band or low band, you select band position B or C appropriately. This eliminates any calculations of any kind, other than switching to the appropriate pre-programmed band and reading the levels from the CRT and the push button attenuators.

The band A position (which is tuneable from 4 to 300 MHz) becomes a "search and destroy" mode for locating nasty harmonic sources, beats, and the like.

Scale Accuracy Tests

Utilizing the 8 MHz locked-in dispersion position and a 30 Hz scan rate, the accuracy of the CRT calibrated scale was checked. The manual says that, "The amplitude display accuracy is +/— 1.5 db for 20 LOG or 40 LOG scales, not including the frequency response error." Under frequency response the manual says, "Within input attenuator set at 10 db, the frequency response including the input attenuator is +/— 1 db from 20 to 300 MHz."

This made us wonder whether the *real* absolute accuracy was +/— 2.5 db (1.5 plus 1). Therefore, we ran the absolute accuracy tests at 54 MHz, 130 MHz, and 211 MHz on both the 20 LOG and 40 LOG SCALES. The results are shown in tabular form.

For the 20 LOG tests we adjusted the Measurements 950 signal generator for -20 dbmv output level (i.e. we ran the VSM-1 with no pads in) and stepped the 950 reference level down in 1 db steps. The CW carrier was centered on the vertical scale so we could eyeball the levels shown directly without interpolation. For the 40 LOG tests the procedure was identical, except the 950 signal generator was set to 0 dbmv (again, no pad switches in on VSM-1).

For both range tests we found the relative scale accuracy good down to the mid CRT scale region where it read

VSM-1 SCALE ACCURACY TESTS

Specified Accuracy: +/— 1.5 db
Test Input Level: 0 dbmv, -20 dbmv
Input Type:
CW (unmodulated) carrier,
channel 13 video, 130 MHz,
channel 2 video (averaged)

INPUT LEVEL (True)		20 LOG Reading	40 LOG Reading
-20	(0)	-20	(0)
-21	(- 2)	-21	(- 2)
-22	(- 4)	-22	(- 4)
-23	(- 6)	-23	(- 6)
-24	(- 8)	-24	(- 8)
-25	(-10)	-25	(-10)
-26	(-12)	-26	(-12+)
-27	(-14)	-27+	(-15)
-28	(-16)	-28+	(-17)
-29	(-18)	-29	(-19)
-30	(-20)	-30+	(-20+)
-31	(-22)	-31+	(-22+)
-32	(-24)	-32+	(-24+)
-33	(-26)	-33	(-26)
-34	(-28)	-34	(-28)
-35	(-30)	-35	(-30)
-36	(-32)	-35.5	(-32)
-37	(-34)	-36.5	(-33+)
-38	(-36)	-37	(-35)
-39	(-38)	**-37+**	**(-36+)**
-40	(-40)	**-37+**	**(-36+)**

All tests made with dispersion set at 8 MHz and scan rate at 30 Hz. **Bold face readings** indicate out of factory spec.

slightly below the real level for a short region. At the low end (last 4 db on 20 LOG scale and last 8 db on 40 LOG scale) we found the display to be *less* than useable.

As the indicated signal gets down *close to the noise* of the VSM-1 (i.e. the noise figure), the ability of the display to discern the signal accurately down into the noise is not good. The VSM-1 manual suggests that the Measurement Range is -40 dbmv to +62 dbmv. You *can* in fact *see signals* that are down in the -35 to -40 dbmv region, but they just don't start registering *accurately* (for absolute measurements) until they climb up to -35 dbmv.

Levels and Stability

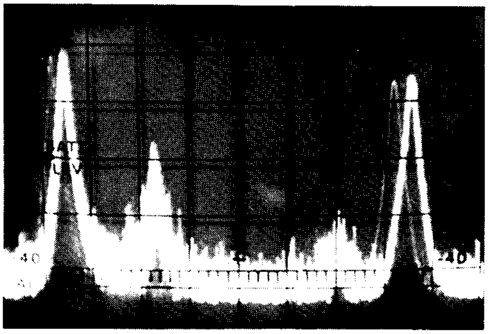
In the 20 db LOG position, the VSM-1 reads levels from -40 (-35) dbmv to +42 dbmv (by adding in attenuators which total 62 db). In the 40 LOG position, the VSM-1 reads levels from -40 (-35) dbmv to +62 dbmv (by adding in attenuators which total 62 db). The CRT display is in 1 db steps in the 20 LOG position, and in 2 db steps in the 40 LOG position.

For absolute level checks, we ran in the 8 MHz locked-in dispersion position and cross calibrated the VSM-1 with the Measurements 950 signal generator. By setting the 950 to 0 dbmv output, we checked the levels at channels 2 and 13 in the 40 LOG scale. Then we placed a 20 db pad in and checked the levels on channels 2 and 13 on the 20 LOG scale.

LOG SCALE	CHANNEL 2	CHANNEL 13
40	0 dbmv	+0.5 dbmv
20	-20 dbmv	-20 dbmv

Switching from the internal battery powering to the external (110 VAC) power supply source showed *no* apparent change in displayed absolute levels.

However, over a period of several weeks, we did notice that absolute accuracy did seem to drift (or vary) from use-time to use-time. We tried to correlate this with the state of the battery charge, but we found *no* direct relationship. Apparently there is *some* small inherent instability (on the order of +/— 1 db) over several days time. However, if the VSM-1 is quickly calibrated with a reference source such as the 950 in the morning and utilized through the day, we found *no measureable* instability at the end of the day when we returned the unit to the shop. With fresh calibration in the morning, the in-use accuracy is *far better* than the +/— 1.5 db specified by the manual (on the order of not being measureable from true readings except as



Locating undesired interferring carrier on ch. 6 video w/ VSM-1; video carrier at far left, next right undesired carrier, color carrier, and ch. 6 audio.

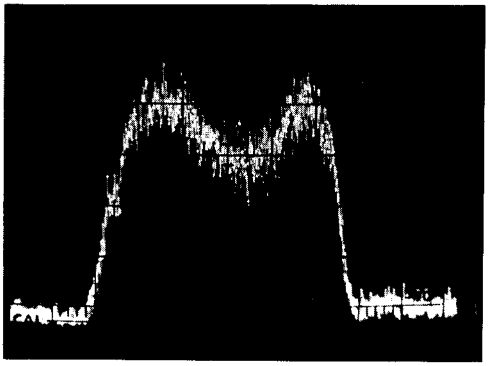
noted in the scale accuracy tests). We tend to believe that anyone concerned with accuracy will probably do calibration once or twice per week anyhow. It is painless and front-panel adjusted, and takes just a few minutes with a reference signal generator.

The manual specs the dial (frequency) accuracy at +/— 3 MHz with "typical accuracy +/— 1 MHz (from 50 to 90 degrees F)". The simple-looking calibrated tape which has the channels and other frequencies imprinted on it looks like it probably would have trouble tracking, but in fact, the unit we had *did very well.* There is a simple -to-use FREQ CAL control on the front that acts like a vernier to reset the tape to a known frequency.

Special Non-FSM Applications

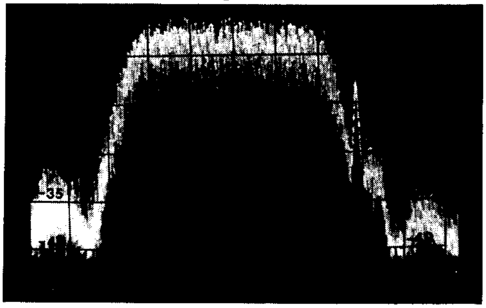
The real justification for the VSM-1, above and beyond the time saved over a normal FSM/SLM, are the extra things you can do with it that you cannot do with a normal FSM/SLM. One of these is searching for beats or spurs which you cannot find with an FSM/SLM.

As shown in the photo here, we located *an interfering carrier* that kept popping up inside channel 6 passband. The carrier was creating a herringbone pattern on channel 6. By displaying the channel 6 display, with channel 6 video, interfering carrier, channel 6 color and channel 6 sound, we were able to place a tuneable trap ahead of the channel 6 processor and search for the carrier source.

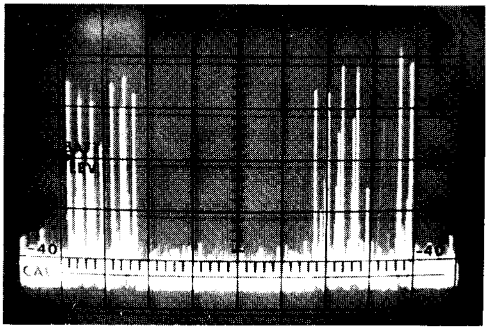


With 260-A wide band noise source as transmitter and VSM-1 as receiver, ch. 10 BPF was swept. Results show filter considerably out of alignment.

With the Sadelco 260-A Analyst as a wide band noise signal source, we drove a channel 10 bandpass filter and displayed the noise-source result on the VSM-1. Utilizing the 260-A wide band noise, we drove a channel 2 processing system (on-channel strip) to determine the response of the channel 2 processing package (with two built-in bandpass filters). At the same time, we also utilized the Measurements 950 as a "marker source" to spot the channel 2 aural carrier frequency, and adjusted the channel 2 aural sound trap while observing whether the sound trap was sufficiently sharp not to degrade channel 2 color. See photos.



With 260-A as source, VSM-1 as receiver, and 950 as marker to pin point ch. 2 aural carrier produced the above on single channel processing unit.



Three programming positions of VSM-1 allow user to switch to 1 of 3 previously set display widths.

What It Lacks

Overall, the VSM-1 functions pretty much the way the manual specs the unit. The only real failing is in the bottom of CRT display region (i.e. the last or bottom four db of display when the signal level approaches the VSM-1 noise level factor). With only modest effort on the part of the operator (i.e. making a reference level alignment with a signal source), the +/— 1.5 db absolute accuracy is easily kept to *within +/— 0.5 db* on the 20 LOG scale. On the 40 LOG scale, it is probably just as good, but the 2 db per division vertical marks are difficult to "eyeball" closer than +/— 1 db.

Previous users of the VSM-1 reported some difficulty with the battery system. The meter provides a CRT display technique for checking the *status of the battery* charge level (i.e. it indicates the *exact* state of charge). When you start out for the day or a measurement, you have a good idea just how much time you have left on the battery (*that we like*). We did notice that if the unit was fully charged and *left sitting* in the shop, that within 4-5 days the state of charge was down 50% or more (without any interim use).

The manual *skips* over a number of things which we believe could be *expanded* to increase the user's comprehension of the unit and its usefulness. In particular, the initial stages handling the signal (i.e. first mixer, second mixer, and tuned line oscillator centered on 636 MHz) are *not* adequately explained. The manual goes into some detail on making "antenna gain" checks and "cross modulation checks", but totally avoids some straight forward talk about getting the best display usefulness out of the VSM-1 for adjusting traps and filters, searching for and correcting beats, and even setting plant levels. A good treatment of proper dispersion/scan rates and displays vs. accuracy would also be helpful. In short, *the manual lacks field-practical operating data.*

The unit we received for review functioned for a few minutes and quit. After checking the manual for instructions on taking off the case (*not* there), we figured it out on our own and located a pair of fuses; one in the +11.3 volt supply line (1/2 amp), and another in series with the battery terminal to ground lead. The battery lead fuse was blown, and on inspection it turned out to be a 1/2 amp slow blow. The schematic showed it to be a 2 amp slow blow, so we replaced the blown fuse. We had no further difficulties.

Finally, we think that some *redesign* might be done on the graticule cover on the CRT. The vertical amplitude scale is as noted. It is marked along the center line only in marks that correspond to 1 db per division on the 20 LOG scale, and 2 db per division on the 40 LOG scale. We would like to see the same scale marks *repeated along a far left and far right vertical graticule line*, so the operator has a better chance of lining up a carrier's amplitude with a graticule scale mark, without having to eyeball across horizontally and "guesstimate" where the amplitude lines up with a scale mark. With the db scale marks only in the center, the operator is forced to use the manual frequency tuning control to bring the desired carrier in line with the center scale marks, which often means you lost 50% of your desired display width *while* making absolute readings.

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